# Studies on Public Economics and Long-term Care

Submitted by **Pei Sun**

to the University of Exeter

as a Thesis for the Degree of

Doctor of Philosophy in Economics

December 2017



I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

Signature..........................................................................................

# Acknowledgements

Firstly, my sincere gratitude goes to my previous supervisor Prof. Gareth D. Myles for his support for my Ph.D study. His patience and wisdom has inspired and led me going through many difficulties. I would also like to convey my utmost gratefulness to my current supervisors, Prof. Surajeet Chakravarty and Dr. Xiaohui Zhang, who have contributed valuable time and work and instructed me in finishing my thesis.

I also appreciate all academic staff in the economics department of Business School, University of Exeter, who ever provided valuable feedbacks to me in the weekly PGR seminars and annual PGR conferences in these past years. I gratefully acknowledge the support from the IT department and the PGR administration team who have given me lots of help and made my life easier. I would also like to extend thanks to all of my postgraduate colleagues for the discussions we had and time we shared.

Lastly, I am grateful to my beloved parents for their unconditional love, support and all the sacrifice they have ever made. Special thanks to my husband for him being so caring and inspiring all the time. I could never go this far without them. I would also like to thank all of my other family members and friends in my life, who have made me a better person.

# Abstract

**The Third Chapter**[1] The aim of this research is to study individual choices of precautionary saving and long-term care spending when an individual faces the uncertainty of after-retirement health shocks. To do this, an improved two-period life-cycle model is employed. This paper also explores how individual choice affects economic development and capital accumulation in an overlapping generation economy. The study shows that the rise in the possibility of getting after-retirement health shocks will result to an increase in long-term care expenditure and the level of precautionary saving. The steady state will also increase in this case.

**The Fourth Chapter** The increasing and intensifying long-term care (LTC) demand brings great financial pressures for both governments and individuals. From the public perspective, the underlying economic question is how adequate real resources can be redistributed to support long-term care need and how efficient the policies targeting is. As many LTC policies are accessed through means tests, individuals saving behaviour can be affected. This paper examines and compares the welfare effects that different means-tested policies have on individuals. We did this by embedding life-cycle models with after-retirement health shocks. Means-tested policies of long-term care, one with a top-up choice, and one without, were then simulated. The results show that the means test regime with a top-up option can bring a higher social welfare. Under this scheme, a higher means test threshold can decrease societys dependency on a social benefit system and increase social welfare.

**The Fifth Chapter** Attendance Allowance and Disability Living Allowance are the disability cash benefits provided for people who are over 65 in the U.K. As the government plans to divert more public resource from these benefits to means-tested local care services, it is important to understand the effects and targeting of these cash benefits first.

[1]The Third Chapter and the Fourth Chapter are co-authored with Prof. Gareth D. Myles

Using the survey data from English Longitudinal Study of Ageing, this study examines the relationship between the receipt of disability cash benefits and recipients' characteristics among those who are over 65 in England. Although income is not a key factor to decide on the receipt of the benefits in the criteria, the results show that it still has a self-selection process where the benefits are given to those who are both most in need and on low incomes.

# Table of Contents

# List of Figures

# List of Tables

# Abbreviations

| | |
|---|---|
| **AA** | Attendance Allowance |
| **ARHS** | After-retirement Health Shocks |
| **ELSA** | English Longitudinal Study of Ageing |
| **DLA** | Disability Living Allowance |
| **LTC** | Long-term Care |
| **OECD** | Organization for Economic Co-operation and Development |

# Chapter 1

# Introduction

Long-term care (LTC), as Chen (2001) puts it, generally refers to “a range of medical, social, personal care, and supportive services required by people who have lost the capability of self-care due to long-term disability or chronic illness.” While LTC services are delivered to younger disabled groups, the majority of LTC recipients are older people. The need for LTC is rising significantly.

Demographic change is one of the reasons behind the increase in the need for LTC. On average across OECD countries, the share of the population aged over 65 years increased from less than 9% in 1960 to 15% in 2010 and was expected to nearly double in the next four decades to reach 27% in 2050. The growth in the proportion of the population aged 80 years and over will be even more dramatic. 4% of the population were 80 years old and over in 2010 (OECD, 2015). Also, life expectancy at aged 65 increases significantly. In OECD countries, life expectancy has been rising by 5.5 years on average for both men and women since 1970. Some of the factors explaining these gains include advances in medical care combined with greater access to healthcare, healthier lifestyles and improved living conditions before and after people reach the age of 66. In addition, structural effects like immigration and the baby boom generation also have very significant effects on the aging population and the rise of LTC demand.

The rapidly growing LTC need brings great financial pressures for both the individuals and the government. Long-term care cost can bring great uncertainty to individuals’ lives. According to Palumbo (1999), the likelihood of a typical 65-year-old person entering a nursing home during his or her lifetime is 43%. Once admitted, the average stay in a long-term care facility exceeds one year. For people who have to pay out-of-pocket, admission to a long-term care facility can quickly deplete one's financial wealth. The increasing and intensifying demand for LTC support is also a challenge to the government. An OECD report shows that, total public spending on LTC accounted for 1.7% of GDP on average across OECD countries, which is a significant share of LTC services funded from public sources. However, most people still see themselves as underinsured. Currently, the challenges that the insurers are facing include increasing public awareness of LTC costs and challenges, risk monitoring and designing innovative and robust solutions for both wealth accumulation and protection products (Castries, 2009).

The British government has the same concern about LTC. In the U.K., according to Falkingham, et al (2010), the population of the U.K. is becoming older. The number of people aged 65 and over in the U.K. grew by 6%, from 7.9 million in 1981 to 9.9 million in 2008. At the same time, the older population itself has been aging. Indeed the fastest-growing age group in the entire population is the one aged 85 and over. The population of the U.K. aged 85 and over in 2008 already represented 2.1% of the total population. The increase in LTC demand was substantial.

LTC provisions in England are in two parallel systems. One is cash benefits provided at the state level, which are mainly Attendance Allowance (AA) and Disability Living Allowance (DLA). The other is social care services operated by local authorities. The entitlement of an individual to get such help from local authorities requires an assessment on a means test.

Current policy discussions on care provisions focus on new arrangements regarding the means test. In fact, the government announced their plan to increase the upper capital threshold in the means test from £23,250 to £118,000 and the lower capital threshold will be raised from £14,250 to £17,000. Under this policy, any people who have capital under £118,000 will receive some help when they are in need of eligible care. However, this policy is delayed to come into effect in April 2020. It seems that the government is trying to go in the direction of increasing the benefits coverage to a larger crowd holding more capital. According to Hancock et al, (2013), the projected cost of social care services and care related disability benefits for older people in 2030 will increase to £25.5 billion (in 2010 prices), which will be more than double the cost of 2010, £12 billion. As a percentage of GDP, the increase in the cost is not that steep from just under 1% to 1.3% by 2030. They also project that in 2030, the new government plans will bring 115,000 more care receivers under public funding than if the current system continued.

The increasing and intensifying need for LTC and the financial concerns had led to broad discussions. On account of the financing of LTC, three studies have been carried out and are constructed into this thesis.

Future uncertain long-term care cost is meaning a greater motivation for young individuals to save. In the first chapter, by embedding a life-cycle model with the factor of after-retirement health shocks, individual choice on LTC expenditure and savings are specified. The effects of individual choice on the capital accumulation process and the steady state level of the whole economy are also examined.

A Means test is an important method used by governments in LTC provisions. The interactions between individuals' savings and LTC spending are affected differently when the parameters of the means test change. Means-tested social welfare policies may drive individuals to reduce their savings. But how this affects the whole economy needs to be analysed further. The second study examines individuals' behaviour under different means test designs and investigates the question of how efficient these different means testing policies are.

The third paper is an empirical research focusing on the significance of effective targeting of the non means-tested cash benefits in the social care system in the U.K. With the government trying to divert more resources to means-tested social care services provided by local government, it is necessary to understand the benefits and the effectiveness of the state cash benefits. To find out who are really targeted by the disability cash benefits and whether the actual outcomes meet the original purpose, it is necessary to estimate the influence of the decisions' outcomes and test the features of the recipients. This helps us understand better how disability cash benefits are distributed across different income and disability levels and the way that pattern differs from the stated aims under the design of the system.

The first two studies are theoretical and the third one is empirical. They focus on investigating individuals' behaviour, changes in the economy and public policies, taking different perspectives of LTC and using multiple methods. This project helps the public have a better understanding and interpretation of the economic phenomena of an aging economy. It can also assist the government to introduce more useful policies on long-term care and accelerate the process of having better solutions in the system for underinsured individuals. In this case, the public provisions will be more effective and efficient.

The thesis is organised as follows. The second chapter is the literature review. The third chapter presents the study of precautionary saving and long-term care expenditure in an overlapping generation economy. Chapter Four looks at individual saving behaviour and the welfare consequences of alternative means-testing policies. The study of the targeting and effectiveness of disability benefits for long-term care in England is included in Chapter Five.

# Chapter 2

# Literature Review

This section mainly reviews the literature on precautionary saving behaviour under future uncertainties and how the life-cycle model is applied in this area. Other relevant literature is introduced in the following chapters separately.

Precautionary saving has become an essential component of economic behaviour and the subject of much research. The proportion of how much precautionary saving occupies the aggregate household wealth has been researched. The results range from 2% (Guiso, Jappelli, and Terlizzese, 1992) to 60% (Dardanoni, 1991). Regardless of the controversial results, the importance of precautionary saving cannot be neglected.

Precautionary saving is motivated by future uncertainty. Caroll and Samwick (1998) found that there is a significant empirical relationship of wealth, precautionary saving, and log of variance of income. By setting the uncertainty to the minimum, they found that the amounts of precautionary saving shrunk by 45%. For those who were aged less than 50, up to a third of the total wealth was held as precautionary savings against the uncertainty. Thus, uncertainty is a vital function shaping households' consumption and saving behaviour.

To test which uncertainty affects consumption and saving behaviour specifically, the uncertainty of longevity has been examined. The lifespan uncertainty helps to explain households' consumption decisions and has certain effects on the slow rate of saving reductions among elderly households (Davies, 1981; Skinner, 1985; and Engen, 1993). Davies (1981) also discovered that under a life-cycle model where only an uncertain lifespan was considered, elderly households spent their financial assets much more slowly than optimal, which means other factors exist affecting household consumption behaviour.

Back in 1963, Arrow (1963) stated that the risk due to factors like nutrition and clothing were far below the risk due to the uncertainty of medical care for households. Extensive research has been devoted to studying the role of medical care. In the early 1970s, Grossman (1972a, 1972b) conducted investigations where health was first treated as a capital, and medical care was first treated as an investment towards this capital. This model is well known as the human capital model, and is used to test the demand for health. It has become a great inspiration for many researches and has been treated as the basis for much research in this sector. In 1977, random factors of illness and death, which are assumed to have effects on health capital, were introduced into the life-cycle model to examine the investments in health capital (Cropper, 1977). In 1998, another factor, the uncertainty of incidence of illness was brought into this model by Picone et al. (1998). They improved Grossman's model, making it a simplified dynamic model in which precautionary behaviour was considered. Picone et al. found that people who are risk-averse often choose to increase their medical care cost when they face future uncertainty. Instead of decreasing consumption, they often choose to spend their savings on medical care cost.

Future healthcare expenses, especially those derived from nursing home care influence the saving and consumption decisions of elderly households greatly, bringing random shocks to their pensions or savings. Such uncertainty becomes a strong motive for precautionary saving behaviour (Palumbo,1999).

The literature about precautionary saving has mostly been focused on the uncertainty of lifespan and not on medical care expenses until Kotlikoff (1989). He pointed out that the risk of morbidity is hard to quantify, while mortality can be used for quantifying lifespan uncertainty. Kotlikoff (1989) improved on the simple life-cycle model. He introduced and assigned probabilities to the health expenditures based on one's past health expenditures, as the causes of the expenses are uncertain or independent.

The life-cycle model has been widely used in studies of consumption decisions, saving behaviour and wealth accumulation. The simple life-cycle model was initially created by

Modigliani and Brumberg (1954) and Ando and Modigliani (1963). One of its hypotheses was that a retired household member should allocate his or her wealth and spend it each year that they expect to live on average. However, afterwards, some studies found that this simple life-cycle model does not reflect actual situations. According to the literature in the 1970s and early 1980s, in studies by White (1978), Mirer (1979) and Danziger et al. (1982, 1983), when the elderly retired, instead of having a decreasing wealth, their savings showed an increasing trend as they grew older. After that, King and Dicks-Mireaux (1982) and Diamond and Hausman (1984) in the 1980s argued that the savings normally increase only in the first few years after retirement and then they decrease along with age, a finding which is more convincing.

Kotlikoff (1989) used a two-period life-cycle model and included the distribution of medical care expenses during the test of precautionary saving and uncertain healthcare payments. In this model, an individual's life is divided into young and old period. They work only in the first period, but consume in both periods. The savings in the first period plus the interest become the consumption in the second period. When individuals are in the second period there is a possibility for them to become ill. Expenditures on medical care can bring them back to health. Individuals can choose to pay the fees, or not to pay as the insurance can cover the cost. Another choice individuals have is to use the government's program but under the sacrifice of assets. Kotlikoff (1989) simulated and examined the consumption and saving behaviour under four different regimes taking the microeconomics data interest rate into consideration. He simulated a life-cycle model with 55 periods, where the last 35 periods are the second period. He found that the aggregate savings can be explained largely by precautionary saving rising by future uncertain health expenditures. Moreover, this uncertainty of health expenditure can bring an extra one third of long run savings and also a decrease in the state wealth level. Palumbo (1999) comments that perhaps the significance about Kotlikoff (1989) was that he pointed out that the medical expenses are incurred independently over time. However, the allocation of the probabilities of random variables was stylized, and a theory model which was not based on empirical observation was used. But this study definitely provided great inspirations for future empirical and theoretical researches.

After this, more researchers have taken future uncertain health expenses into consideration when precautionary behaviour is being investigated. Hubbard et al. (1994a) argue that the medical expenses, lifespan and uncertain earnings are the most important uninsured risks. The life-cycle model incorporated these three factors of uncertainty is built to explain the distribution of wealth holdings among the American households.

Then Hubbard et al. (1995) found that although the life-cycle model indicates that households keep saving money for their retirement consumption, a sizable proportion of the population always holds no wealth. So besides the uncertain future health expenditure, medicaid programmes also have effects on the households' saving behaviour. As more factors were taken into consideration, the research started to study the heterogeneity effects and the interactions of assets-restricted programmes like Medicaid with precautionary saving behaviour. This was an important step in the study where the role of Medicaid was truly considered. In this study, the simple life-cycle model and dynamic programming model were analyzed separately to explore the relationships between welfare programmes and precautionary saving behaviour. Great differences exist between the two results. Social insurance programmes affect the saving behaviour of both actual and potential recipients. This is because even if people do not encounter out-of-pocket medical expenses, the prediction or realization of them still has potential effects.

On saving behaviour, Hubbard et al. (1995) suggest that, by using a life-cycle model of consumption and saving affected by uncertainty, households with different earning levels have different saving levels. Households with lower lifetime income tend to have inconsistent saving behaviour and little wealth accumulation even during their high-income periods (before retirement). On the other hand, for households who have a relatively high lifetime earning level, wealth accumulation behaviour is consistent. Significant savings can be achieved before their retirement. The situation of holding no wealth is more likely to happen to low-income households, which can be seen as behaviour to maximize the utility of asset-based, means-tested welfare programmes. In the case of precautionary saving behaviour, low-income households prefer to reduce their savings to qualify for the subsidy program.

In 1999, studying the choices of consumption levels of elderly households, Palumbo (1999) created a dynamic, structural health uncertainty model of household consumption decisions in which uncertainty of future health expenses was well considered. He used data from Panel Study of Income Dynamics (PSID) and explained the slow rate of dissolving wealth among American elderly households. Palumbo (1999) highlights the fact that, in the health uncertainty model, households optimally maintain additional financial wealth to offset potential out-of-pocket medical expenses of the future. The model used differs from the normal life-cycle model by treating out-of-pocket medical expense as happening randomly. Moreover, longevity was treated as unpredictable. Instead of assigning probability theoretically and giving specified households' preference by simulating models like previous studies, this study estimated probability distribution as random variables using micro data. Moreover, Polumbo included data in his health-uncertainty model. He used distribution functions in the life-cycle model to involve micro-date to estimate medical expenses. Introducing the parameters of uncertainty allows for precautionary saving to be examined not only when people are in young period but also during their retirement.

It has been found that, among elderly Americans, uncertain out-of-pocket medical expenses are an important motive for people to save as a precaution. For a typical couple, the proportion of precautionary saving arising from this uncertainty accounts for 7% of their annual consumption during their early retirement. The sizeable amounts of precautionary saving due to uncertain medical expenses are still not sufficient to explain completely why elderly Americans hold their wealth in their early years of retirement.

Studies of the interactions between precautionary savings and healthcare have evolved into studies on healthcare quality, and multiple risks, which is a more practical and comprehensive approach.

In 2006, the question of how healthcare quality affects economic inequality and precautionary saving behaviour was tested by Jappelli et al. (2006). They found through observation that patients in places with poor healthcare quality need to wait for a long time before treatment, thus health shocks have much worse effects on them. Italian microeconomic data was used in this research to indicate geographic quality differences. The study revealed that districts with lower quality have greater incomes and more precautionary savings. Additionally, the unequal distributions of healthcare quality may be a good explanation of the economic inequality and saving decisions. Jappelli et al. also provided insights into the validity of the life-cycle model and policy implications for the design of healthcare system. Their research helped to explain why people are not dissolving their savings during their early retirement and tried to give a solution to the problems of unequal distributions of healthcare.

Considering factors other than Medicaid and lifespan, Vidangos (2009) conducted a study on household welfare, precautionary saving and social insurance under multiple risks. The model employed assumed that the households' earnings were subject to variations in health shocks, unemployment, job transformation, wages, work hours and income. The research found out that fully insured disability, health and unemployment did not weigh much in explaining the precautionary behaviour. However, what the insured shocks bring to the wage and residual component of households' income are significantly larger gains compared to other factors. Moreover, these two shocks accounted for more than 60% of precautionary savings.

Recently,the topic of aging population and long-term care problems has led to many discussions. Long-term care has also become a specific uncertainty when the interactions of precautionary savings are studied.

In 2007, Hemmi et al. (2007) conducted a study investigating the interactions between individuals' precautionary saving behaviour and their decisions of whether to pay for after-retirement health shocks (ARHS). On the basis of the life-cycle model from Kotlikoff (1989), a simple growth model was built, in which the expected utilities of paying or not paying for the (ARHS) were compared. This study shows that in an underdeveloped economy where households have a decreasing or low income, they do not like to pay for ARHS as it costs more. Individuals choose not to have precautionary savings under such condition. However, when the economy is developed and people have an increasing or a high income, once their incomes reach a certain level, they choose to pay for ARHS.

There are also some other studies, which have focused on different aspects of long-term care. Wouterse et al. (2012) used the Latent Markov model and tested the relationship between health and healthcare expenditures. Compared to the individuals with poor current health and high health expenditures, individuals with good current health and low healthcare expenditures tended to have higher expenditure on long-term care in the future. The expectancy of the cost-saving effects should not be too high. De Meijer et al. (2011) conducted a study on the determinants of long-term care spending. Instead of treating time-to-death as the main determinants of the LTC expenditures traditionally, the control for disability was introduced, and this shows that individuals who live alone or died from diabetes, mental illness, stroke, respiratory and digestive disease have high LTC expenditures. Long term care insurance is also a very heated subject. Gupta (2007) produced a study, in which optimal decisions of investment, consumption, as well as long-term care insurance purchase are given to help people make better choices.

# Chapter 3

# Precautionary Saving and Long-term Care Expenditure in an Overlapping-generation Economy

## 3.1 Introduction

Long-term care (LTC) is the provision of assistance and services to people who, because of disabling illness or conditions, have a limited ability to perform basic daily activities such as bathing, cleaning, and cooking. It is a problem mainly, but not exclusively, for the elderly (Cremer, et al, 2017). It is known that ageing populations have become the norm in many countries and also a challenge for most developed countries, and the demand for long-term care (LTC) has increased dramatically.

The tremendous long-term care cost is becoming a major concern for both the public and households. Individuals often see themselves as underinsured (Catries, 2009), and those who are over 65 years old have a 43% chance of entering a nursing home. Once admitted, the average stay in a long-term care facility exceeds one year (Palumbo, 1999). Because nursing home cost are virtually uninsured, admission to a long-term care facility can quickly deplete a person's finances (Palumbo, 1992). Precautionary saving, as Leland (1968) suggests, is due to the future income being random rather than terminating. Large amounts of unexpected future expenses for long-term care will become a key motive for young people to save.

Getting health shocks and bearing the LTC cost when individuals are old affects individuals' choices on consumption and precautionary saving decisions. Furthermore, changes will affect the capital accumulation process and the steady state level of the whole economy. To explore this problem, this study makes the parameters of savings and LTC expenditure interact in a setting of a two-period life-cycle model with after-retirement health shocks (ARHS). It then presents an analysis of capital accumulation in an overlapping generations economy. The shocks give an additional reason for investing in capital relative to an economy without the shocks. The idea is to explore the consequence of the shocks for the growth path and the long-run equilibrium of the economy.

Since the 1990s, many studies have focused rigorously on the issue of precautionary saving in response to after-retirement health uncertainty. Hubbard (1994a; 1994b; 1995) and Palumbo (1999) suggest that future health uncertainty results in great precautionary saving motives and plays an important role in individuals' consumption and saving behaviour over a life cycle. Hemmi et al. (2007) examined the precautionary saving motives arising from the decision of whether to pay for after-retirement health shocks. They found that at low levels of income, individuals choose not to save to finance the cost of after-retirement health shocks. However, when their income is sufficiently high, they choose to finance these shocks.

The changes in individuals' behaviour of consumption and saving due to after-retirement uncertainty also have significant effects upon the capital accumulation and development of the economy. Jitsuchon and Saito (1995) demonstrated that the degree of heterogeneous uninsured idiosyncratic shocks tightly relate to the cross-country differences in saving and per-capital growth. Rodriguez (1999) suggests that precautionary saving has more significant effects when the economy where households also save against idiosyncratic risks is compared to an economy where only wages and interest are considered (Skinner, 1988; Caballero, 1991).

Rodriguez (1999) found the introduction of idiosyncratic risks in Solow's growth model opens the gate to multiple steady states. Hemmi et al. (2007) discovered that the saving behaviour bringing to a growing economy gives rise to multiple steady state equilibrium. Mizushina (2009) completed a theoretical study on the effects of intergenerational transfers of healthcare using overlapping generation model. The study also suggested that long-term care may lower the steady state level of capital in the economy. However, the steady state level of welfare may be enhanced by long-term care in an aging economy.

Comparing to previous literatures, this paper contributes to take the research further into the area to study more specifically on the uncertainty of future LTC spending. It also improves the two-period life-cycle model by introducing the assumption that the spending on LTC after ARHS cannot recover individuals' health states to those before experiencing the shocks, which can reflect better of the real-life situations. This assumption can be widely used on models studying precautionary behaviour under health uncertainties

This chapter is organized as follows. Section Two reviews a model of individual choice. Section Three embeds the model of individual choice within an overlapping generations economy. Section Four conducts an analysis of the overlapping generations economy.

## 3.2 Individual Choice

The life of each individual is divided into two periods. In the first period, the individual works, consumes, and saves. In the second period, the individual is retired and lives off accumulated savings. If the individual suffers ARHS then savings are divided between consumption and healthcare cost. When there are no ARHS then savings are consumed. There are no bequests. The level of saving that is chosen takes into account the probability of ARHS and the effect that the ARHS have upon quality of life.

In this individual choice utility function, the level of consumption in the first period is denoted by $c_y$. Every individual faces the same probability $p$, that they will suffer ARHS. The level of consumption in period $2$ when ARHS occur is denoted by $c_h$, and by $c_g$ consumption when it does not. The effect of ARHS is to reduce the quality of life in the sense of reducing the level of utility derived from any given level of second-period consumption. If ARHS occur, the impact can be reduced by expenditure, $h$, on healthcare.

The level of healthcare expenditure is chosen after the ARHS are realised but the saving to fund healthcare is chosen before.

The lifetime level of utility is

$$U = u(c^y) + \beta[pu(d(h)c^h) + (1-p)u\left(c^g\right)], \tag{3.1}$$

where $\beta \leq 1$, $u' > 0$ and $u'' < 0$ . The term $d(h)$ represents the impact of ARHS on effective consumption after mitigation by healthcare expenditure of $h \geq 0$ . It is assumed that $d(0) < 1$ , so that, in the absence of healthcare expenditure, the ARHS reduce the effective level of second-period consumption and, hence, the level of utility obtained from any given level of consumption. It is further assumed that

$$0 < d(h) < 1, \quad d'(h) > 0, \quad d''(h) < 0. \tag{3.2}$$

So, although a health shock reduces the level of effective consumption, some of the reduction can be restored by healthcare expenditure. It is not possible to restore all consumption through expenditure on healthcare.

The individual supplies a single unit of labour in the first period of life. Under this assumption the budget constraints facing the individual are

$$c^y = w - s, \tag{3.3}$$

$$c^h = (1+r)s - h, \tag{3.4}$$

$$c^g = (1+r)s, \tag{3.5}$$

where $w$ is the wage rate, $r$ is the rate of interest, and $s$ is the level of saving. Substituting from (3.3) to (3.5) into the utility function gives

$$U = u(w-s) + \beta[pu(d(h)\left([1+r]\,s - h\right)) + (1-p)u([1+r]s)] \tag{3.6}$$

The form of utility in (3.6) reveals the range of effects that ARHS have upon the incentive to save. In the state that an ARHS occurs then higher saving is necessary to pay for healthcare to mitigate the effect. The ARHS reduce the effective level of consumption for any given level of saving and affects the marginal utility from additional saving. It can be observed that following ARHS

$$MU_s = d(h)\,[1+r]\,u'\left(d(h)\left([1+r]\,s-h\right)\right), \tag{3.7}$$

so that for given $s$ the $MU_s$ is increased by lower effective consumption but decreased by the direct effect of $d(h)$. The net effect upon the incentive to save depends on the balance of these two effects.

The first-order necessary conditions for choice of $s$ and $h$ are

$$\begin{aligned} U_s &\equiv -u'(w-s) + \beta d(h)[1+r]pu'(d(h)([1+r]s-h)) \\ &\quad +\beta[1+r](1-p)u'\left([1+r]\,s\right) = 0, \qquad (3.8) \\ U_h &\equiv d'(h)([1+r]s-h) - d(h) = 0. \qquad (3.9) \end{aligned}$$

To have a preliminary analysis, total differentiations of these necessary conditions demonstrate the effects of wage rate and the possibility of ARHS upon the levels of saving and planned care expenditure. The calculation of comparative statics is in the appendix.

The results show that wage rate has a positive relationship with saving and planned care expenditure, and an increase in the wage rate raises the level of both parameters. The effects of an increase in the possibility of ARHS on these depend on the term $du'\left(c^h\right) - u'\left(c^g\right)$. If it is positive then an increase in the probability of ARHS will raise saving and care expenditure. However, this can be negative in which case an increase in $p$ will reduce both saving and care expenditure. Clearly, $c^h < c^g$, so with concavity it follows that $u'\left(c^h\right) > u'\left(c^g\right)$. However, $d < 1$ captures the impact of ARHS. A more severe ARHS is captured in a lower value of $d$ and this pushes in the direction of $du'\left(c^h\right) - u'\left(c^g\right) < 0$. If this effect is sufficiently strong an increase in the probability of a very severe health shock will most likely reduce saving and expenditure on healthcare. Now a specific utility function of individual choice will be introduced and simulations will be carried out to examine the interactions of parameters in further.

The increase or the decrease of the possibility of the ARHS can have different results on the savings and the spending on LTC. The intuitions are, when individuals face the increasing possibility of ARHS occurring in the old period, they can either increase their savings to prepare for the future increasing LTC cost, or they can increase their spending to improve their current health and decrease the savings for the future to prevent health shocks.

### 3.2.1 Example

It is worth developing an example to explore the possibilities. This example is employed to provide a numerical simulation of how the parameters are related and also to lay the groundwork for the overlapping-generation economy that is introduced below.

The lifetime level of utility is

$$U = \ln(c^y) + \beta\left[p\ln\left(\delta\left[1 + \frac{1-\delta}{\delta}\frac{h}{1+h}\right]c^h\right) + [1-p]\ln\left(c^g\right)\right] \tag{3.10}$$

with $\delta < 1$. This specification implies that

$$d\left(h\right) = \delta\left[1 + \frac{1-\delta}{\delta}\frac{h}{1+h}\right].$$

It can be observed that

$$d(0) = \delta < 1, \quad d(h) > 0 \ \ \forall h > 0,$$

and

$$\lim_{h \to \infty} d(h) = 1.$$

Hence, the ARHS reduces effective second-period consumption and cannot be entirely mitigated by any finite level of healthcare expenditure.

Using the budget constraints, utility becomes

$$U = \ln(w - s) + \beta p \ln \left( \left( \delta + [1 - \delta] \frac{h}{1+h} \right) ((1+r)s - h) \right) + \beta [1 - p] \ln ((1+r)s).$$

This can be factored to give

$$U = \ln(w-s)+\beta p \ln (\delta + h) - \beta p \ln (1+h) + \beta p \ln ((1+r)s - h) + \beta (1-p) \ln ((1+r)s).$$

The necessary conditions for the choice variables $s$ and $h$ are

$$-\frac{1}{w-s} + \beta p \frac{1+r}{(1+r)s - h} + \beta (1-p) \frac{1}{s} = 0,$$

and

$$\frac{1}{\delta + h} - \frac{1}{1+h} - \frac{1}{(1+r)s - h} = 0.$$

These necessary conditions can be resolved into

$$\begin{aligned} -(1+\beta)(1+r)s^2 + \beta(1+r)ws + (1+\beta(1-p))hs - \beta(1-p)hw &= 0, && (3.11) \\ (1-\delta)((1+r)s - h) - (\delta + h)(1+h) &= 0. && (3.12) \end{aligned}$$

(3.11) can be written as

$$(1-\delta)(1+r)s = \delta + 2h + h^2,$$

so that

$$h = \max \left\{ 0, \sqrt{(1-\delta)(s(1+r)+1)} - 1 \right\},$$

For those cases in which $h > 0$, the optimal $s$ solves

$$-(1+\beta)(1+r)s^2 + \beta(1+r)ws + (s - \beta(1-p)(w-s)) \left( \sqrt{(1-\delta)(s(1+r)+1)} - 1 \right) = 0.$$

The implications of these first-order conditions are now investigated by inserting parameter values and computing an implicit plot. With the variables are set at $\delta = 0.25$, $r = 0.05$, $p = 0.2$, $\beta = 1$ the solution for $h$ as a function of $s$ is

$$h = \sqrt{0.75\left(s(1.05) + 1\right)} - 1,$$

hence $s$ is the solution to

$$-2.1s^2 + 1.05ws + \left(\sqrt{0.75\left(1.05s + 1\right)} - 1\right)(1.8s - 0.8w) = 0.$$

Computing the solutions a range of values of the wage rate give the results reported in Table 1. For the data in the table the elasticity of saving with respect to the wage rate is $0.998$ while the elasticity of healthcare expenditure is $0.941$. The elasticity of $d$ with respect to the wage is $0.3$.

Table 3.1: Simulation Results of the Individual Choice

| w | s | h | d |
|---|---|---|---|
| 2 | 1.0291 | 0.2492 | 0.3996 |
| 3 | 1.5479 | 0.4032 | 0.4655 |
| 4 | 2.0644 | 0.5413 | 0.5134 |
| 5 | 2.5792 | 0.6677 | 0.5503 |
| 6 | 3.0927 | 0.7848 | 0.5798 |
| 7 | 3.6050 | 0.8945 | 0.6041 |
| 8 | 4.1166 | 0.9980 | 0.6246 |
| 9 | 4.6274 | 1.0962 | 0.6422 |
| 10 | 5.1376 | 1.1899 | 0.6575 |
| 11 | 5.6473 | 1.2797 | 0.6710 |

A comparative statics exercise to analyse individual choice can be conducted by plotting the pair of first-order conditions and then considering the effect of parameter changes. The calibrated necessary conditions are plotted in Figure 3.1 for $\delta = 0.25$, $r = 0.05$, $p = 0.2$, $\beta = 1$ and $w = 10$. The intersection of the u-shaped curve (the solutions to (3.12) is with the higher line (one branch of the solution set for (3.11)) gives the choices identified in Table 3.1. A change in $w$ only affects the line. An increase in $w$ shifts the curve up, so both $s$ and $h$ rise. The probability only affects the line. An increase in $p$ pivots the curve about the vertical intercept and makes the gradient steeper. Hence, $h$ and $s$ rise. An increase in $\delta$ shifts this curve up, which reduces h and s.

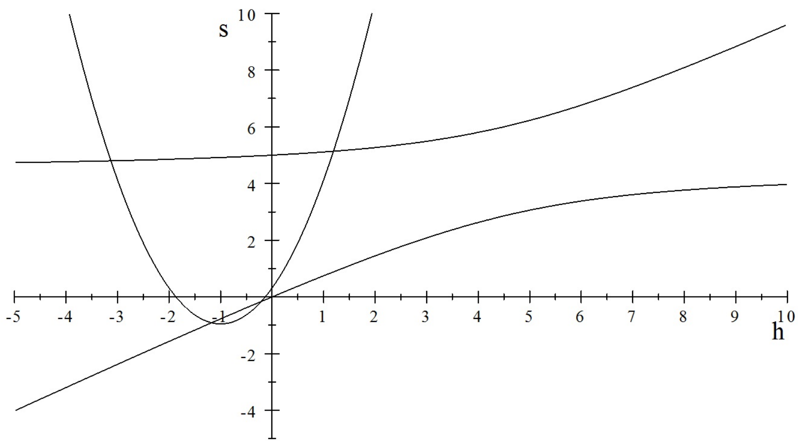


Figure 3.1: Simulations of necessary conditions

Summarising, for the parameter values $\delta = 0.25$, $r = 0.05$, $p = 0.2$, and $w = 10$,

1. $\frac{dh}{dw} > 0, \ \frac{ds}{dw} > 0$

2. $\frac{dh}{dp} > 0, \ \frac{ds}{dp} > 0$

3. $\frac{dh}{d\delta} < 0, \frac{ds}{d\delta} < 0$

The analysis of the decision faced by the individual demonstrates how the possibility affects the saving decision and the expenditure on healthcare. Intuitively, individuals with higher income choose to accumulate their savings and consume more on LTC expenditure. When the possibility of getting an ARHS increases, the precautionary savings and the planned care spending increase. With an increasing chance of experiencing health shocks in the future, the LTC spending increases, and individuals choose to increase precautionary savings. A larger $\delta$ indicates a less severe ARHS. So the results show that a more severe ARHS drives individuals to save more and have more planned care spending.

## 3.3 Overlapping Generation Economy

The next step is to embed the model of individual choice with ARHS into an overlapping generations (OLG) economy framework. This will permit an analysis of the intergenerational distribution of the burden for elderly care and the effect that it has upon capital accumulation.

The basic idea underlying the analysis is that all consumers are the same when young, and face the same probability $p$ for the occurrence of ARHS. When a generation is old the probability for an individual becomes the proportion of the population that is affected by AHRS. So, based on the assumption that the population is sufficiently larger, a proportion $p$ of the population suffers ARHS every period. The occurrence of ARHS divides the old consumers into two types that have different consumption patterns and life outcomes.

The key economic effect is that expenditure on healthcare is subtracted from the output which is available for consumption. Output is divided between consumption, saving, and the cost of healthcare. Hence, healthcare places a burden on the society as a whole.

### 3.3.1 Consumers

Consider a consumer born at time $t$. This consumer has preferences given by

$$U_t = u(c_t^y) + \beta \left[ pu\left(d(h_t)c_t^h\right) + [1-p]\, u\left(c_t^g\right)\right], \tag{3.13}$$

where the subscript $t$ denotes the year of birth. It is assumed that each consumer inelastically supplies a single unit of labour. The within-period budget constraints are

$$\begin{aligned} c_t^y &= w_t - s_t, \\ c_t^h &= (1+r_{t+1})s_t - h_t, \\ c_t^g &= (1+r_{t+1})s_t. \end{aligned}$$

Repeating the optimization analyzed in section Individual Choice generates the consumption and saving functions

$$c_t^y = c_t^y\left(w_t, r_{t+1}, p\right), \tag{3.14}$$

$$c_t^h = c_t^h\left(w_t, r_{t+1}, p\right), \tag{3.15}$$

$$c_t^g = c_t^g\left(w_t, r_{t+1}, p\right), \tag{3.16}$$

$$s_t = s_t\left(w_t, r_{t+1}, p\right),$$

plus the level of healthcare expenditures if the consumer is subject to ARHS

$$h_t = h_t\left(w_t, r_{t+1}, p\right). \tag{3.17}$$

These functions capture the behaviour of the household side of the economy.

### 3.3.2 Production

Output at time $t$, $Y_t$, is produced by a representative firm using a production process with constant returns to scale in capital, $K_t$, and labour, $L_t$. Capital is obtained from the savings of the consumers in the economy's single good. The production function is given by

$$Y_t = F(K_t, L_t).$$

The production function can be written in terms of the output-labour ratio and the capital-labour ratio as

$$y_t = f(k_t),$$

with $y_t = \frac{Y_t}{L_t}$, and $k_t = \frac{K_t}{L_t}$. The usual assumption of profit maximization for the firm implies that the input choices of the firm equate marginal revenue product with factor prices

$$r_t = f'(k_t), \tag{3.18}$$

and

$$w_t = f(k_t) - k_t f'(k_t). \tag{3.19}$$

### 3.3.3 Allocation of Output

The population is assumed to grow at the constant rate $n$ so

$$H_{t+1} = (1+n)\, H_t$$

It is assumed that $H_t$ is large enough (for all $t$) to ensure that the individual probability of an ARHS $p$ can be treated as equal to the proportion of population that suffer from ARHS.

When proportion $p$ of the population suffers from ARHS, the division of output between consumption and capital accumulation must satisfy the condition that

$$Y_t = H_t c_t^y + p H_{t-1} c_{t-1}^h + [1-p]\, H_{t-1} c_{t-1}^g + p H_{t-1} h_t + [K_{t+1} - K_t]\,.$$

Since each consumer inelastically supplies one unit of labour, it follows that $H_t = L_t$. Dividing through $H_t$ allows the condition for the division of output to be written as

$$y_t = c_t^y + p\frac{c_{t-1}^h}{1+n} + [1-p]\,\frac{c_{t-1}^g}{1+n} + p\frac{h_t}{1+n} + [1+n]\, k_{t+1} - k_t. \tag{3.20}$$

The allocation of output described in (3.20) demonstrates clearly how expenditure on healthcare is a real resource cost for the economy. It reduces the consumption that is available for individuals who experience ARHS and for individuals who do not.

### 3.3.4 Capital Market

Equilibrium in the capital market requires the stock of capital in time period $t+1$ to be equal to the level of saving in time period $t$. This requirement implies that

$$\begin{aligned} K_{t+1} &= H_t s_t \\ &= H_t w_t - H_t c_t^y. \end{aligned}$$

Using (3.14), (3.18), and (3.19) the capital market equilibrium condition can be written in terms of the capital-labour ratio

$$\begin{aligned} (1+n)\,k_{t+1} &= w_t - c_t^y \\ &= w_t - c_t^y\,(w_t, r_{t+1}, p) \\ &= f(k_t) - k_t f'(k_t) - c_t^y\,(f(k_t) - k_t f'(k_t), f'(k_{t+1}), p)\,. \end{aligned} \tag{3.21}$$

Equation (3.20) is the basic first-order nonlinear difference equation for the capital-labour ratio that describes the evolution of the economy from one period to the next.

Given the time path of the capital stock the factors rewards can be obtained from (3.17), and (3.18) and demands from (3.13) to (3.15). It is a fact that the demand function for $c_t^y$ depends on $p$ results in the time path of capital being dependent on the probability of ARHS.

### 3.3.5 Steady State

The steady state is achieved when the capital-labour ratio is constant. This implies that consumption, saving, and healthcare expenditure are also constant. From (3.20) the steady-state capital-labour ratio satisfies the identity

$$(1+n)\,k = f(k) - kf'(k) - c_y^t\,(f(k) - kf'(k), f'(k), p)\,. \tag{3.22}$$

## 3.4 Comparative Statics

The dynamic path for the economy (3.20) and the steady state condition (3.21) can be used to investigate how the economy is affected by the possibility of ARHS. It is clear from Section Two that ARHS affect the saving decision of each individual and this must lead to a change in the aggregate level of capital.

The first step in the analysis is to determine what effect the ARHS has on the path of capital accumulation. An insight into this can be obtained in the following way. It can be assumed that $k_t$ is fixed, and the effect of an increase in the probability of an ARHS upon $k_{t+1}$ is determined. From (3.20) we have

$$(1+n)\,dk_{t+1} = -\frac{\partial c_t^y}{\partial r}dk_{t+1} - \frac{\partial c_t^y}{\partial p}dp,$$

or

$$\frac{dk_{t+1}}{dp} = \frac{-\frac{\partial c_t^y}{\partial p}}{(1+n)+\frac{\partial c_t^y}{\partial r}}. \tag{3.23}$$

To determine the sign of (3.22) observe from the capital accumulation condition (3.20) that

$$\frac{dk_{t+1}}{dk_t} = \frac{-f''\left(k_t+\frac{\partial c_t^y}{\partial w_t}\right)}{(1+n)+\frac{\partial c_t^y}{\partial r_t}}.$$

If consumption when young is normal $\left(\frac{\partial c_t^y}{\partial w_t}>0\right)$ and the process is monotonically increasing $\left(\frac{dk_{t+1}}{dk_t}>0\right)$ then $(1+n)+\frac{\partial c_t^y}{\partial r_t}>0$. When this condition is satisfied, the effect of the probability $p$ on the next period capital stock, $k_{t+1}$, depends on value of $\frac{\partial c_t^y}{\partial p}$.

From the previous calculations

$$\frac{\partial c_t^y}{\partial p} = \frac{\left[d''\left(\left[1+r_{t+1}\right]s_t-h_t\right)-d'\right]\beta\left[1+r_{t+1}\right]\left[du'\left(c_t^h\right)-u'\left(c_t^g\right)\right]}{U_{hh}U_{ss}-U_{hs}^2}.$$

So the key determinant of the effect of an increase in $p$ is the term $du'\left(c^h\right)-u'\left(c^g\right)$. If $du'\left(c^h\right)-u'\left(c^g\right)>0$ then $\frac{\partial c_t^y}{\partial p}<0$. This is the intuitive case: an increase in the probability of each consumer suffering ARHS causes saving to rise to provide finance for healthcare in the case of bad health. However, it is only worth increasing saving if the marginal utility of consumption in the case of bad health, $du'\left(c^h\right)$, exceeds the marginal utility in the case of good health, $u'\left(c^g\right)$. Both these marginal utilities are endogenous because they are determined by consumer choice but the conditions for consumer choices do not tie-down this relationship.

For the example in section 3.2 we have $\frac{\partial s_t}{\partial p}>0$ so $\frac{\partial c_t^y}{\partial p}<0$. This results in $\frac{dk_{t+1}}{dp}>0$, so an increase in the probability of ARHS increases the capital stock.

The second step in the analysis is to determine the effect that ARHS have on the steady-state capital-labour ratio. This can be obtained by totally differentiating the steady-state condition (3.21) to determine the effect of $p$ on $k$. The total differential is given by

$$dk\left[(1+n)+kf''+\frac{\partial c_t^y}{\partial w}kf''+\frac{\partial c_t^y}{\partial r}f''\right]+dp\left[\frac{\partial c_t^y}{\partial p}\right]=0.$$

This can be solved as follows:

$$\frac{dk}{dp}=-\frac{\frac{\partial c_t^y}{\partial p}}{(1+n)+kf''+\frac{\partial c_t^y}{\partial w}kf''+\frac{\partial c_t^y}{\partial r}f''}.$$

The next step is to evaluate the numerator and the denominator. This can be done by appealing to stability of the equilibrium.

For stability of the steady state we need

$$-1<\frac{dk_{t+1}}{dk_t}<0.$$

From (20)

$$\frac{dk_{t+1}}{dk_t}=\frac{-k_tf''+\frac{\partial c_t^y}{\partial w}k_tf''}{(1+n)+\frac{\partial c_t^y}{\partial r}f''}$$

so, if the equilibrium is stable and $-k_tf''+\frac{\partial c_t^y}{\partial w}k_tf''>0$, then evaluated at the steady state it follows that

$$(1+n)+kf''+\frac{\partial c_t^y}{\partial w}kf''+\frac{\partial c_t^y}{\partial r}f''<0.$$

The key condition is then that

$$\frac{\partial c_t^y}{\partial w}-1<0$$

This follows because

$$\frac{\partial c_t^y}{\partial w}=1-\frac{\partial s_t}{\partial w}$$

and we have shown

$$\frac{\partial s_t}{\partial w}>0.$$

So, assuming stability the effect is determined by the sign of $\frac{\partial c_t^y}{\partial p}$. It then follows from the discussion above that if $du'\left(c^h\right)-u'\left(c^g\right)>0$ then an increase in the probability of ARHS will increase the steady state capital-labour ratio.

The conclusion of this section is that ARHS can increase the capital-labour ratio on the growth path and in the steady state if individuals have an incentive to make additional saving to finance possible healthcare expenditure.

## 3.5 Simulations

This section conducts a simulation analysis of the model using the functional forms from Section 3.2. The intent of the simulation analysis is to show how the growth path of the economy is affected by changes in the parameters $p$ and $\delta$ that describe the extent of the ARHS problem.

Assuming that the production function is given

$$f(k_t) = k_t^{\alpha}.$$

The capital accumulation condition then becomes

$$(1+n)\,k_{t+1} = (1-\alpha)\,k_t^{\alpha} - c_t^y\left((1-\alpha)\,k_t^{\alpha}, \alpha k_{t+1}^{\alpha-1}, p\right).$$

The preferences of a consumer born at time $t$ are based on those from the earlier example

$$U = \ln(c_t^y) + p\ln\left(\left[\delta + [1-\delta]\,\frac{h_t}{1+h_t}\right]c_t^h\right) + [1-p]\ln\left(c_t^g\right).$$

The challenge with the example is that there is no explicit solution for the consumption levels. This implies that the direct approach to obtaining the capital accumulation condition cannot be used. An alternative approach has to be used that is based on the necessary condition for consumer choice.

The optimal choice of consumption by a young consumer born at $t$, $c_t^y$, is defined implicitly by

$$
\begin{aligned}
&-(1+\beta)(1+r_{t+1})(w_t-c_t^y)^2+\beta(1+r_{t+1})w_t(w_t-c_t^y)\\
&\quad+\left(\sqrt{(1-\delta)\left((w_t-c_t^y)(1+r_{t+1})+1\right)}-1\right)\\
&\quad*\left[(1+\beta(1-p))(w_t-c_t^y)-(1-p)w_t\right]=0
\end{aligned}
$$

or

$$
\begin{aligned}
&-(1+\beta)(1+\alpha k_{t+1}^{\alpha-1})((1-\alpha)k_t^{\alpha}-c_t^y)^2+\beta(1+\alpha k_{t+1}^{\alpha-1})(1-\alpha)k_t^{\alpha}((1-\alpha)k_t^{\alpha}-c_t^y)\\
&\quad+\left(\sqrt{(1-\delta)\left((w_t-c_t^y)(1+\alpha k_{t+1}^{\alpha-1})+1\right)}-1\right)\\
&\quad*\left[(1+\beta(1-p))((1-\alpha)k_t^{\alpha}-c_t^y)-(1-p)(1-\alpha)k_t^{\alpha}\right]=0
\end{aligned}
$$

But consumption is given by the output that is not saved to generate capital in $t+1$ , so

$$
c_t^y\left((1-\alpha)k_t^{\alpha},\alpha k_{t+1}^{\alpha-1},p\right)=(1-\alpha)k_t^{\alpha}-(1+n)k_{t+1}.
$$

Using this relationship

$$
\begin{aligned}
&-(1+\beta)(1+\alpha k_{t+1}^{\alpha-1})((1+n)k_{t+1})^2+\beta(1+\alpha k_{t+1}^{\alpha-1})(1-\alpha)k_t^{\alpha}(1+n)k_{t+1}\\
&\quad+\left(\sqrt{(1-\delta)\left((1+n)k_{t+1}(1+\alpha k_{t+1}^{\alpha-1})+1\right)}-1\right)\\
&\quad*\left[(1+\beta(1-p))((1+n)k_{t+1}-(1-p)(1-\alpha)k_t^{\alpha}\right]=0.
\end{aligned}
\tag{3.24}
$$

The equation (3.23) traces the dynamics. Given a value of $k_0$ the value of $k_1$ can be found and then the system can be iterated forward. The following figures show the trends of how $k_1$ change in a Solow growth model given other changed parameters.

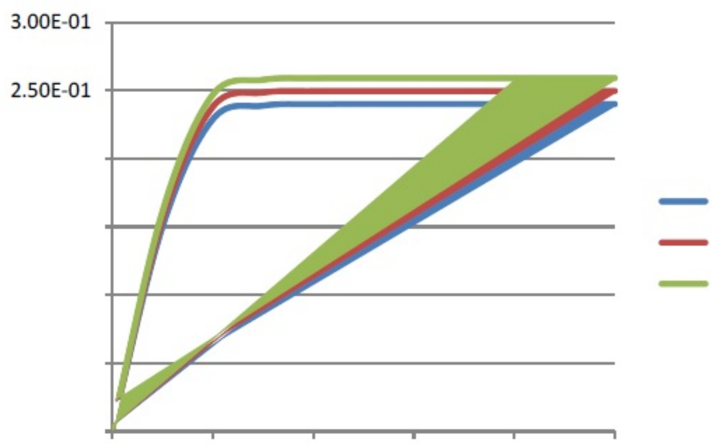


Figure 3.2: Simulations of Stock of Capital for p

Figure 3.2 shows growth paths for different values of the probability of ARHS, and as $p$ increases, $k_1$ changes from the ones below to the above. The stock of capital increases more quickly when $p$ is higher, and reaches a higher steady state level. As the possibility of getting health shocks increases, individuals increase their precautionary saving and consumptions and healthcare spending in the second period thus the level of capital stock $k_1$ increases. It shows that the ARHS provide a positive stimulus to capital accumulation in the calibration.

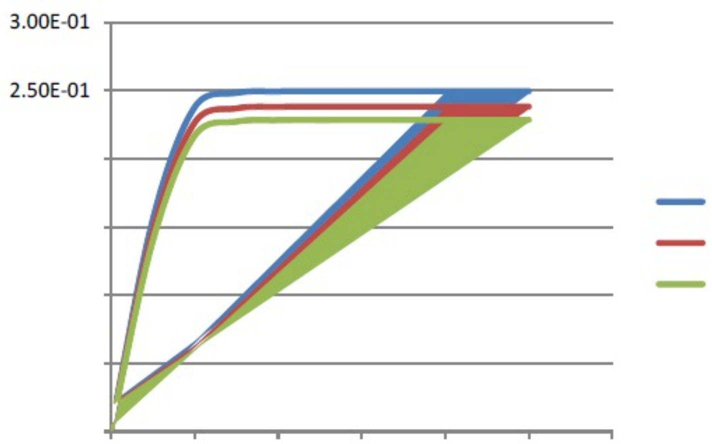


Figure 3.3: Simulations of Stock of Capital for $\delta$

Figure 3.3 displays the effect of increasing $\delta$. A higher value of $\delta$ means that the shock to health after retirement is less severe. The figure shows that an increase in $\delta$ reduces the capital stock, as $k_1$ changes from the higher ones to the lower one. The less severe the health shocks are, the individuals are more likely to decrease their precautionary savings and their healthcare spending, as well as the consumptions in the second period. Thus $k_1$ shows the trend of falling.

Overall, the simulation matches the conclusion in the last section, and a higher chance of ARHS happening increases the steady state level. A more severe health shock makes the capital stock increase.

## 3.6 Golden Rule

It is worthwhile finding the steady state of the golden rule. The idea is to find out that what policy with regard to ARHS gets closer to the golden rule.

Take the output division equation

$$y_t = c_t^y + p\frac{c_{t-1}^h}{1+n} + [1-p]\frac{c_{t-1}^g}{1+n} + p\frac{h_t}{1+n} + [1+n]\,k_{t+1} - k_t.$$

Now take this to the steady state

$$y = c^y + p\frac{c^h}{1+n} + [1-p]\frac{c^g}{1+n} + p\frac{h}{1+n} + nk.$$

This then gives

$$f(k) - nk = c^y + p\frac{c^h}{1+n} + [1-p]\frac{c^g}{1+n} + p\frac{h}{1+n}$$

So consumption per capita is the same as standard. Hence the golden rule is

$$f'(k) = n.$$

The simulations with the Maple file shows that it is correct but the value of $\alpha$ of the production function has to be very low for the economy to get anywhere near the golden rule. I checked the file by working out the model without the ARHS which can be done explicitly for the log utility. The answer was the same. So the simulations from this point use a low alpha.

## 3.7 Policy

The sources of funding of the long-term care cost of the government are various from country to country. Most public funding of care benefits relies on tax revenues. Considering a tax on labour income that is used to make a payment and a subsidy to healthcare cost to those suffering from ARHS. This section intends to explore how such policy affects capital stock and expected utility.

It is assumed that the government must have a balanced budget every period. This implies that

$$\tau w_t H_t = p\upsilon H_{t-1},$$

or

$$\upsilon = \frac{(1+n)\,\tau w_t}{p}.$$

Repeating the construction of the capital accumulation equation gives

$$\begin{aligned}
-(1+\beta)(1+r_{t+1})(w_t\,(1-\tau)-c_t^y)^2+\beta(1+r_{t+1})w_t\,(1-\tau)\,(w_t\,(1-\tau)-c_t^y)\\
+\left(\sqrt{(1-\delta)\,((w_t\,(1-\tau)-c_t^y)(1+r_{t+1})+1)}-1\right)\\
*\,[(1+\beta\,(1-p))(w_t\,(1-\tau)-c_t^y)-(1-p)w_t\,(1-\tau)]=0
\end{aligned}$$

or

$$\begin{aligned}
-(1+\beta)(1+\alpha k_{t+1}^{\alpha-1})((1-\alpha)\,k_t^{\alpha}\,(1-\tau)-c_t^y)^2+\beta(1+\alpha k_{t+1}^{\alpha-1})\,(1-\alpha)\,k_t^{\alpha}\,(1-\tau)\,((1-\alpha)\,k_t^{\alpha}\,(1-\tau)\,-\\
+\left(\sqrt{(1-\delta)\,(((1-\alpha)\,k_t^{\alpha}\,(1-\tau)-c_t^y)(1+\alpha k_{t+1}^{\alpha-1})+1)}-1\right)\\
*\,[(1+\beta\,(1-p))((1-\alpha)\,k_t^{\alpha}\,(1-\tau)-c_t^y)-(1-p)\,(1-\alpha)\,k_t^{\alpha}\,(1-\tau)]=0
\end{aligned}$$

Simulations are carried out with different $\tau$ and the setting of $\delta=0.25$, $r=0.05$, $p=0.2$, $\beta=1$ and $w=$ on parameters of $h$, $s$, $k$, $\upsilon$, and the log utility function.

Table 3.2: Calibration Results of the Policy

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $\tau$ | -0.3 | -0.2 | -0.1 | 0 | 0.1 | 0.2 | 0.3 |
| $\nu$ | -0.985 | -0.651 | -0.322 | 0 | 0.315 | 0.621 | 0.918 |
| $s$ | 0.321 | 0.293 | 0.265 | 0.237 | 0.210 | 0.184 | 0.157 |
| $h$ | 0.127 | 0.116 | 0.104 | 0.092 | 0.081 | 0.069 | 0.057 |
| $k$ | 0.313 | 0.285 | 0.258 | 0.232 | 0.205 | 0.179 | 0.153 |
| $EU$ | -0.879 | -0.999 | -1.130 | -1.271 | -1.427 | -1.599 | -1.792 |

The results from simulating the economy for different tax rates and healthcare payments are shown in the Table 3.2 above. Individuals with higher savings who have healthcare cost, also have higher capital and higher expected utility. Those who have high LTC spending, which are also less healthy people, bring a higher capital state level. This is because it feeds back into greater saving to cover healthcare costs and this raises the capital stock.

## 3.8 Conclusion

This paper studied individual choice in precautionary saving and long-term care spending when an individual faces the uncertainty of after-retirement health shocks and explores how individual choice affects the economic development in an overlapping generation economy. A two-period life-cycle model was employed and developed to study individuals' behaviour. This model can also be carried out to study problems of long-term or chronic illness. Many countries are in the process of delivering or improving the LTC social health system. How the LTC cost affects individuals' saving behaviour and the economic capital accumulation is of great significance. This paper can provide great theoretical support to policy-makers of social care systems of providing LTC.

The analysis showed that individuals who had a higher income often held more savings and had more LTC expenditure. A higher possibility or a more severe ARHS generated higher motivation, and individuals chose to accumulate their savings and increase their spending on LTC. Meanwhile ARHS can stimulate the steady-state level to increase and cause an increase in the capital-labour ratio.

An example of the results is that in China, from year 2000 to 2015, the saving rate increased from 35.8% to 47.1% (OECD, 2017). One of the reasons is the increasing chance of occurrence of ARHS. In developing countries like China, individuals' life expectancy is increasing while economy is booming, and the chances for individuals to get ARHS are rising. However, on the other hand, the social support system is not complete, and most of the care expenditure is out-of-pocket money. According to the World Bank, although it had been decreasing, the share of out-of-pocket health expenditure was still as high as 72% in 2015 (TWB, 2017). Individuals were therefore motivated to increase their savings.

This paper explored government policy on covering the LTC cost and provided an insight into how such policy affects capital stock. This can be studied further where instead of having an equal budget for everyone, the poor people can gain higher subsidy through government policy although a lower tax is paid. Future research can also consider that instead of identical individual choice, various choices developed from different levels of income are possible under the effects of government means-tested policies.

## 3.9 Appendix

### 3.9.1 Comparative Statics of Individual Choice

Given the Individual Choice in a general case,

$$U = u(c^y) + \beta[pu(d(h)c^h) + (1-p)u\left(c^g\right)] \tag{3.25}$$

The first-order necessary conditions for choice of $s$ and $h$ are

$$U_s \equiv -u'(w-s) + \beta d(h)\,[1+r]\,pu'\left(d(h)\left([1+r]\,s-h\right)\right) + \beta\,[1+r]\,(1-p)\,u'\left([1+r]\,s\right) = 0, \tag{3.26}$$

$$U_h \equiv d'(h)\left([1+r]\,s-h\right) - d(h) = 0. \tag{3.27}$$

Total differentiation of these necessary conditions gives the effect of an increase in the wage rate upon the levels of saving and planned healthcare expenditure

$$\begin{aligned} \frac{ds}{dw} &= \frac{U_{hs}U_{hw} - U_{hh}U_{sw}}{U_{hh}U_{ss} - U_{hs}^2}, \\ \frac{dh}{dw} &= \frac{U_{hs}U_{sw} - U_{ss}U_{hw}}{U_{hh}U_{ss} - U_{hs}^2}. \end{aligned}$$

It is always the case that $U_{hh}U_{ss} - U_{hs}^2 > 0$ as the second-order condition for the optimization. Using the facts that

$$\begin{aligned} U_{hs} &= d'(1+r), \\ U_{hw} &= 0, \\ U_{hh} &= d''\left([1+r]\,s-h\right) - d' < 0, \\ U_{sw} &= -u''(c^y), \end{aligned}$$

the comparative statics effects can be calculated to be

$$\begin{aligned} \frac{ds}{dw} &= \frac{u''(c^y)\left[d''\left([1+r]\,s-h\right) - d'\right]}{U_{hh}U_{ss} - U_{hs}^2} > 0, \\ \frac{dh}{dw} &= \frac{-u''(c^y)d'(1+r)}{U_{hh}U_{ss} - U_{hs}^2} > 0. \end{aligned}$$

Hence, an increase in the wage rate increases saving and the planned level of expenditure to mitigate an ARHS.

Similarly, the effects of an increase in the probability of an ARHS are given by

$$\begin{aligned} \frac{ds}{dp} &= \frac{U_{hs}U_{hp} - U_{hh}U_{sp}}{U_{hh}U_{ss} - U_{hs}^2}. \\ \frac{dh}{dp} &= \frac{U_{hs}U_{sp} - U_{ss}U_{hp}}{U_{hh}U_{ss} - U_{hs}^2}, \end{aligned}$$

To evaluate these expressions, note that

$$\begin{aligned}
U_{hs} &= d'(1+r), \\
U_{hp} &= 0, \\
U_{hh} &= d''\left([1+r]\, s-h\right) - d' < 0, \\
U_{sp} &= \beta\,[1+r]\,[du'(c_h) - u'(c_g)]\,.
\end{aligned}$$

The comparative statics effects can then be written in detail as

$$\begin{aligned}
\frac{ds}{dp} &= \frac{-\left[d''\left([1+r]\, s-h\right) - d'\right]\beta\,[1+r]\left[du'\left(c^h\right) - u'\left(c^g\right)\right]}{U_{hh}U_{ss} - U_{hs}^2}, \\
\frac{dh}{dp} &= \frac{d'(1+r)\beta\,[1+r]\left[du'\left(c^h\right) - u'\left(c^g\right)\right]}{U_{hh}U_{ss} - U_{hs}^2}.
\end{aligned}$$

It can be seen that both of these expressions have the sign of $du'\left(c^h\right) - u'\left(c^g\right)$. If $du'\left(c^h\right) - u'\left(c^g\right)$ is positive then an increase in the probability of an ARHS will increase saving and care expenditure. However, this can be negative in which case an increase in $p$ will reduce both saving and care expenditure. Clearly, $c^h < c^g$, so with concavity it follows that $u'\left(c^h\right) > u'\left(c^g\right)$. However, $d < 1$ captures the impact of the ARHS. A more severe ARHS is captured in a lower value of $d$ and this pushes in the direction of $du'\left(c^h\right) - u'\left(c^g\right) < 0$ . If this effect is sufficiently strong an increase in the probability of a very severe health shock will most likely reduce saving and expenditure on healthcare.

The effects of an increase in the interest rate are given by

$$\begin{aligned}
\frac{ds}{dr} &= \frac{U_{hs}U_{hr} - U_{hh}U_{sr}}{U_{hh}U_{ss} - U_{hs}^2}. \\
\frac{dh}{dr} &= \frac{U_{hs}U_{sr} - U_{ss}U_{hr}}{U_{hh}U_{ss} - U_{hs}^2},
\end{aligned}$$

To evaluate these, note that

$$\begin{aligned}
U_{hs} &= d'(1+r), \\
U_{hr} &= d's, \\
U_{hh} &= d''\left([1+r]\, s-h\right) - d' < 0, \\
U_{sr} &= \beta\left[du'\left(c^h\right) + (1-p)u'\left(c^g\right)\right] + \beta\,[1+r]\, s\left[dpu''\left(c^h\right) + (1-p)u''\left(c^g\right)\right] \\
U_{ss} &= u''(c^y) + \beta\,[1+r]^2\left[dpu''\left(c^h\right) + (1-p)u''\left(c^g\right)\right].
\end{aligned}$$

The comparative statics effects are

$$
\begin{aligned}
\frac{ds}{dr} &= (U_{hh}U_{ss} - U_{hs}^2)^{-1}\left[d'(1+r)d's\right. \\
&\quad - \left[d''\left([1+r]\,s-h\right)-d'\right]\left(\beta\left[du'\left(c^h\right)+(1-p)u'\left(c^g\right)\right]+\beta\,[1+r]\,s\left[dpu''\left(c^h\right)+(1-p)u''\left(c^g\right.\right.\right. \\
\frac{dh}{dr} &= (U_{hh}U_{ss} - U_{hs}^2)^{-1}\left[d'(1+r)\left(\beta\left[du'\left(c^h\right)+(1-p)u'\left(c^g\right)\right]+\beta\,[1+r]\,s\left[dpu''\left(c^h\right)+(1-p)u''\right.\right.\right. \\
&\quad \left.- \left[u''(c^y)+\beta\,[1+r]^2\left[dpu''\left(c^h\right)+(1-p)u''\left(c^g\right)\right]\right]d's\right].
\end{aligned}
$$

Further constraints are needed before we can make a conclusion on how the interest rate affects individual choice in a general sense.

# Chapter 4

# Individual Saving Behaviour and the Welfare Consequences of Alternative Means-tested Policies

## 4.1 Introduction

Long-term Care (LTC) is currently provided in many developed countries, but the way it is organized varies. Some countries provide LTC in a variety of settings, including short-term or long-term institutionalization, home based and ambulatory services; some have the provision of care shared between the family, public and private sectors; and some establish different boundaries between the health and social care services. The access to LTC services is usually means-tested (European Commission, 2008 ;Kraus et al., 2010). This is the case in England, which has a National Health Service (NHS) and health and social LTC services are delivered to the population under different schemes. LTC provisions in England are in two parallel systems. One is cash benefits provided at a state level, and the other is social care services operated by local authorities. The entitlement of an individual to get such help from local authorities requires an assessment using a means test.

A means test is an important design that many countries have adopted for the population to access social care benefits. Through an assessment against an individual's assets or income, it allows governments to target benefits to poorer households. Governments can flexibly adjust the margins of the targeted group by setting different parameters in the means tests. It can also help governments to control spending on relevant benefits. However, the means test has been criticized for having the disadvantages of discouraging individual savings and work efforts, thereby creating dependence on the welfare state

(Sefton et al., 2008).

The demand for long-term care (LTC) services faces a considerable increase due to the population aging and the changes in the family structure. The pressure of providing and paying for long-term care has become a major concern for not only individuals, but also for the health system and policymakers. Many countries are striving to make policy reforms on LTC benefits, including the efforts to increase the coverage of the benefit policies. For instance, in England, the government plans to increase the upper capital threshold in the means tests of the local LTC services from £23,250 to £118,000, and the lower capital threshold from £14,250 to £17,000. Such a change aims to benefit more people to receive public provisions. However, besides the huge increasing benefits outlays, the incentives for more individuals to spend their savings may rise. Thus it is vital to understand the effects of the changes in means-tested policies on the individuals and the economy.

One research question is that how the changes in a means test affect individuals' saving behaviour, consumption choice, and the welfare state facing a future uncertainty of LTC spending. In addition, this paper proposes to answer how adequate real resources can be redistributed to support long-term care needs and how efficient the targeting is of means-tested policies. This paper addresses these questions by focusing on testing the welfare effects that means-tested policies with different threshold and subsidy levels bring to different groups of individuals across income and health levels. We mainly consider two regimes of means-tested LTC policies in this research. One is not allowing a top-up, which means that the individuals who pass the means test and have government support can only use what is given. For example, if an individual is qualified to get government support of a three-hour volunteer help, or a free stay in a care home but in a lower standard room, he or she is not allowed to upgrade the care service to more hours or to a better room. The second regime of means-tested benefit policy modeled in this paper allows a top-up. This policy provides the option for qualified recipients to pay on top of the acquired public support. Taking the same example, after being qualified for the care services or a care home room, an individuals is allowed to have an option to choose to have better services, at an extra cost using their own finance.

These two regimes of means-testing for LTC services or LTC allowance are very commonly adopted. In a system where the LTC benefit system targets to provide the basics of LTC to the people having the least wealth, the initial state is to introduce a system where individuals have some allowance or have access to certain services. Depending on the design of the system, these LTC services within the system can be very limited. It involves the system to be better organised to intergrade the services for the government to use before the recipients have the options to top up on the covered services.

For example, in China, the governments support on LTC is not systematic. In some rural areas, the LTC based on appointed clinic beds can be covered if you are qualified for means-testing programmes (e.g. Wubaohu), but the services you are allowed to have are targeted and you cannot choose to have more advanced services, e.g. upgrading the hospital bed, or appointing home care services. While in England, the LTC systems allow individuals to wave or choose their care services to some extent after they are entitled to the government funding of their LTC services. One important reason for this to happen is that the local authorities of England are in charge of planning and carryout of the LTC services and choosing LTC institutes. Within the system, all the LTC resource is under control by the government. Thus the differences between the two regimes are more of the differences of the entire LTC systems. It is important to demonstrate the differences on the outcomes from the perspectives of individual utility and social welfare level of these two regimes, so that the policy makers can make more informative and rational decisions in designing the LTC benefit systems.

A life-cycle model with after-retirement health shocks (ARHS) is firstly embedded, in which individuals choose the consumption and the spending on long-term care over their life-cycle. The funding methods of their long-term care cost after experiencing ARHS include personal savings and government support. Then after constructing individual choices under the two regimes of means-tested LTC policies, welfare functions are applied. Meanwhile,under each means-tested LTC policy, the paper gives a thorough analysis of how an individual's saving behaviour changes when facing different government subsidies and means-tested thresholds. The welfare consequences of alternative means-tested policies are investigated and compared.

The results show that under a means-tested LTC benefit which does not allow any top-up, if the government is facing a fixed budget, it should reduce the means-tested threshold and increase individual subsidy to achieve a higher social welfare. For the means tests which allow a top-up, the policies that have a higher means-tested threshold and a lower individual subsidy can achieve a higher social welfare. Comparing the two regimes, the means test with the top-up option can bring a higher social welfare. It has a wider coverage of recipients, but it also requires a higher cost.

The next section is an explanation of the individual's life-cycle model. Section Three and Section Four contain the models and simulations of the two schemes of means-tested policies. The paper gives a conclusion in Section Five, where further analysis, limitations and future studies are discussed.

## 4.2 Literature Review

Future long-term care can be treated as an uncertainty, which has an influence on people's precautionary behaviour of saving. The literature review in the opening of the thesis discussed many studies on precautionary savings and future uncertainties, such as earnings, medical spending and the length of life. Many studies have also included the effects from social policies.

In order to examine the implications of different financing mechanisms for random health expenditures for the macroeconomic saving rate, Kotlikoff (1989) constructed models under the regimes of no insurance, actuarially fair insurance, actuarially unfair insurance, and incomplete insurance provided through a government program somewhat similar to the U.S. Medicaid system. The results showed that introducing actuarially fair insurance to the economy with uncertain health expenditures reduces the steady state level of wealth by 12%. Switching from the fair insurance arrangement to a Medicaid type program with an asset test further reduces steady state wealth by 75%.

While studying the role of uncertainties in motivating people to save, Hubbard et al. (1994b) also considered the effects that come from taxing and from means-tested social welfare programs. They constructed a general multi-period life-cycle model before they estimated the stochastic processes using available cross-section and panel data sets on households. They simulated the income and asset histories of low-wealth individuals and found out that the ones who had lower wealth were still in the same state in the years after. The saving behaviour was discouraged by the implicit tax associated with increasing assets. By contrast, households with higher levels of wealth were less likely to qualify for social insurance programs, so that saving was less discouraged. Considering the impact from the social welfare programs on individuals' savings, Zhao (2017) studied the impact of social insurance on individual choices and welfare. Applying a dynamic general equilibrium model with uncertain medical expenses and individual health insurance choices, he found that social insurance not only distorts saving and labor supply decisions, but also has an effect on the reductions of private health insurance in the U.S..

Although there are plenty studies that consider the effects of public welfare policy on precautionary saving against future uncertainty of health spending, research which further applies life-cycle models to study policy design of means test is limited. However, the design on means-tested pension scheme has been discussed a lot. Means test in pension scheme is more complicated, the adjustment of means test is usually through the change of taper rate or marginal tax rate. Apart from the consumption/saving decisions, the studies on the means test of pension schemes also take into considerations the effects of the work/leisure decisions made by people of working age.

Sefton et al. (2009) used a dynamic programming model to consider the effects of a policy reform that reduced the marginal tax rates on private income of means-tested retirement benefits from 100% to 40%. Their analysis suggests that policy reform can encourage the poorest third of all households both to save more and delay retirement, and have the opposite effects on richer households. Kumru and Piggott (2009) extended this approach using a large scale general equilibrium stochastic overlapping generations model calibrated to UK data. They found that a 100% taper rate for a means test is optimal. In trying to find the optimum design of means-tested pension design, Fehr and Uhde (2014) modelled an economy without social security, and then introduced pension systems of various institutional designs and compared the costs arising from liquidity constraints as well as distortions of labor supply and the accumulation of savings. They identified a positive role of means-tested pension benefits against private assets from a long run welfare perspective.

## 4.3 The General Model

### 4.3.1 Individual Choice

Individual choice $U$ describes expected lifetime utility of an individual considering the effects of health shocks and healthcare expenditure, where $U' > 0$ , $U'' < 0$ . This is constructed based on the life-cycle model implemented by Modigliani and Brumberg (1954), Ando and Modigliani (1963), Kotlikoff (1988) and Hemmi et al. (2007).

$$U = \ln(c^y) + \beta p \ln\left((\delta + \frac{h}{a})c^h\right) + \beta(1-p)\ln(c^g) . \tag{4.1}$$

The life-cycle model of individual choice contains two periods. Individuals work, consume and save in the first period, and retire and live off the savings in the second period. Utility is derived from the consumptions of the two periods. The key feature in this paper is that in the second period of the model, there may be a health shock which will induce long-term care. The effects of the health shock can be reduced by expenditure on long-term care, but they cannot be offset completely. Each individual takes into account the probability of suffering a health shock when choosing the lifetime consumption plan.

In the model, $c^y$ is the individual's consumption of the first period of life. When a person is in the second period an after-retirement health shock (ARHS) occurs with a probability $p$ $(p \leq 1)$ . $c^h$ is the level of consumption in period 2 when an ARHS occurs, while $c^g$ is the consumption when it does not occur. When an ARHS occurs the effects can be reduced by $h$ , which is the expenditure on long-term care. The level of healthcare expenditure is chosen after the ARHS is realised.

The idea in the model is that after an ARHS, before healthcare is paid ($h = 0$), the health shock reduces the individual's effective consumption to $\ln(\delta c^h)$. As healthcare expenditure, $h$, increases, the level of effective consumption $\ln((\delta + \frac{h}{a})c^h)$ also increases. The utility improves due to the receipt of care, and a positive relationship between healthcare expenditure and effective consumption. The effectiveness of $\delta + \frac{h}{a}$ is determined by constant $a$ and it is implicitly assumed to satisfy the condition $\delta + \frac{h}{a} < 1$ . This is justified by the fact that the level of $h$ is restricted by the individual's budget constraint, and the effectiveness of consumption cannot be restored to the level in the absence of an ARHS. This specification of the model implies that once the ARHS occurs, the bad effects it has on health cannot be fully removed. The discount factor $\beta \leq 1$ is applied to the second period utility.

Consumption of the first period $c^y$ is equal to the total income $w$ minus the savings $s$ . When individuals move into the second period of life, savings with interest added, $(1+r)s$, finance the consumption when old. Moreover, in the situation that an ARHS occurs, savings also have to finance any health expenditure that is made so, for the retirement period, $c^h = (1 + r)s - h$, where $h \geq 0$ . Thus, the model has the following budget

Table 4.1: Variable list of Individual Choice Model

| | |
|---|---|
| $c^y$ | Consumption in the first period |
| $c^h$ | Consumptions in the second period if one has health shocks |
| $c^g$ | Consumptions in the second period if one does not have health shocks |
| $\delta$ | The bad effects from health shocks, $0 < \delta < 1$ |
| $h$ | Long-term care expenditures if one has health shocks |
| $a$ | A constant that is set to be large enough to make $\delta + \frac{h}{a} < 1$ |
| $\beta$ | Discount factor in the second period |
| $p$ | Possibilities of the individuals getting health shocks in the second period of life |
| $w$ | Wages that individuals get in the first period |
| $s$ | Savings from the first period |

constraints,

$$\begin{aligned} c^y &= w - s, \\ c^h &= (1+r)s - h, \\ c^g &= (1+r)s. \end{aligned}$$

So the utility function of individual choice becomes,

$$U = \ln(w-s) + \beta p \ln\left((\delta + \frac{h}{a})((1+r)s - h)\right) + \beta(1-p)\ln\left((1+r)s\right). \quad (4.2)$$

It is assumed that there is a population of individuals with incomes between $[\underline{w}, \overline{w}]$ distributed evenly along the density function $f(w)$. All individuals have the same preferences of choices and the same probability of having an ARHS. The government does not observe income directly but can observe the level of wealth (savings plus interests).

### 4.3.2 Policy Description

As mentioned above, the consumption of individuals in the second period is $(1+r)s$, and we can define the individuals' wealth level in the second period as $W$, and $W = (1+r)s$. The benefits policies considered in this paper are based on the means-testing policy $(\Omega, h^p)$.

We assume that there exists a wealth threshold of $\Omega$ from the government to determine whether an individual is eligible for the given public provisions $h^p$, in which $\Omega = (1+r)s^p$, and $s^p$ is the means test threshold of the individual saving. It needs to be mentioned that, the determinations of the level of $\Omega$ are not considered in this paper, along with the role of taxation. It is the change in $\Omega$ and $h^p$ and its effects on individual behaviour and the economy that we need to examine.

Any change in $\Omega$ or $s^p$ can be interpreted as the government trying to change the targeted benefits recipients, either increasing the benefit coverage to a wider crowd to achieve a higher fairness, or decreasing the benefit threshold to a poorer group to provide public provisions to those who are most in need. The variable $h^p$ represents individual subsidy or personal allowance in the means-tested benefit policy once an individual becomes a benefit recipient.

Two different provision schemes of means testing policies will be analyzed and compared; the first scheme does not allow individuals to top up, and the second one allows the top-up. Under both schemes, the elderly who have wealth under $\Omega$ are qualified to receive public provisions for healthcare, while those whose wealth is larger than $\Omega$ have to bear the entire cost of health care by themselves. The aim of the analysis is to demonstrate how social welfare is affected by such variations in the government means-tested policies.

**Scheme 1**. No top-up

Scheme 1 does not allow top-up. This means when those who are qualified are provided with public funded healthcare, they are not given the option of getting more or better care even if they intend to top up the service or cash benefits using their own money. In this case, the government provides healthcare $h^p$ to individuals with wealth less than $\Omega$. Individuals who qualify for the public provision must spend the amounts of $h^p$ on healthcare.

**Scheme 2**. Top-up

The effects of permitting a top-up of government provision are also considered. If individuals are qualified for the government provided provisions for healthcare, they can choose whether to pay more to upgrade the service or get better package. So in the model of Scheme 2, government provides $h^p$ to eligible individuals who are also given options to make additional expenditure, $h^t$ ($h^t \geq 0$), on healthcare. Some people will choose to top up, and some will still just consume the public provisions. In this case, individuals who pass the means tests have the healthcare expenditure of $h^p$ or $h^p + h^t$.

## 4.4 Individual Choice Under Different Saving Behaviour - Scheme 1

The first scheme provides a fixed level of healthcare subsidies after eligibility determined by a means test. Once the means tests are passed, individuals' LTC cost will be covered by public provisions, and no top-up is allowed. Any individual with wealth above the cut-off level is responsible for providing their own care. This gives a motivation for some individuals to keep savings lower than or on the threshold level to pass the means test. So this gives us incentives to construct three utility functions along income. The first utility is for the individuals who have savings under the threshold and pass the means tests. The second utility is to describe those who should have savings above the threshold but intentionally keep savings under the thresholds to pass means tests. The last utility function represents those who do not pass the means tests and pay for the healthcare using their own finance

The means test is passed if the level of wealth $W$ is less than or equal to $\Omega$. Denoted by $s^p$, this is the maximum possible saving level to pass the means test. Hence

$$\Omega = (1 + r)s^p. \tag{4.3}$$

and,

$$W = (1+r)s \tag{4.4}$$

For people who save $s > s^p$ and fail the means tests, the healthcare cost $h$ has to be covered by themselves. The utility in their second period of life following an ARHS is

$$\ln\{(\delta + \frac{h}{a})c^h\}. \tag{4.5}$$

where

$$c^h = (1+r)s - h. \tag{4.6}$$

For people who save an amount $s \leq s^p$ and pass the means tests, public healthcare subsidies of $h^p$ is provided to cover their healthcare spending. The healthcare spending in their second period $h = h^p$ , and the utility of their second period of life with following an ARHS is,

$$\ln\{(\delta + \frac{h^p}{a})c^h\}, \tag{4.7}$$

with

$$c^h = (1+r)s. \tag{4.8}$$

These distinct outcomes result in three different indirect utility functions which are now derived. Group 1 consists of the individuals whose wage level is below $w^p$ , and wealth level $W$ is under the means-test level $\Omega$ , who qualify for the government provision $h^p$ of long-term care spending. When the wage level is between $w^p$ and $w^*$, individuals reduce their savings intentionally to remain qualified for the government provision. Individuals in this stage are Group 2. After the wage level hits $w^*$, individuals tend to prefer to save more for their future rather than spending more. The individuals whose wage level is above $w^*$ will be classified as Group 3, and this comprises those who have to pay for the long-term care using their own finance.

The utility function of type $U_1$ is given by

$$U_1 = \ln(w - s) + \beta p \ln\left((\delta + \frac{h^p}{a})(1+r)s\right) + \beta(1-p)\ln\left((1+r)s\right). \tag{4.9}$$

$$\max_{\{s\}} U_1 = \ln(w - s) + \beta p \ln\left(\delta + \frac{h^p}{a}\right) + \beta \ln((1+r)s). \tag{4.10}$$

Taking the first order condition regarding $s$,

$$\frac{\partial u_1}{\partial s} = -\frac{1}{w-s} + \frac{\beta}{s}$$

Making $\frac{\partial u_1}{\partial s} = 0$, so the necessary condition for the choice of $s$ gives

$$s = \frac{\beta}{1+\beta} w, \tag{4.11}$$

so indirect utility is

$$U_1 = \ln\left(\frac{1}{1+\beta} w\right) + \beta p \ln\left(\delta + \frac{h^p}{c}\right) + \beta \ln(\frac{\beta(1+r)}{1+\beta} w). \tag{4.12}$$

The means test will be passed provided that

$$\frac{\beta}{1+\beta} w \leq s^p, \tag{4.13}$$

or

$$w \leq \frac{\Omega}{1+r}\frac{1+\beta}{\beta}. \tag{4.14}$$

Hence for individuals in the income range $[\underline{w}, w^p]$, where $w^p = \frac{\Omega}{1+r}\frac{1+\beta}{\beta}$ , the optimal level of saving is consistent with passing the means test.

Now $w^*$ is defined as the income level at which an individual saves sufficiently over the government threshold and fails the means test. It is clear that $w^* > w^p$ since individuals just above $w^p$ have an incentive to keep savings low in order to pass the means test and benefit from government provided healthcare. Hence, for income levels $w$ in the range $w^p < w < w^*$ , the saving level is kept artificially low at $s^p$ . The indirect utility function then becomes

$$U_2 = \ln(w - s^p) + \beta p \ln\left((\delta + \frac{h^p}{a})(1+r)s^p\right) + \beta(1-p)\ln\left((1+r)s^p\right). \tag{4.15}$$

$$U_2 = \ln(w - s^p) + \beta p \ln\left(\delta + \frac{h^p}{a}\right) + \beta \ln\left((1+r)s^p\right). \tag{4.16}$$

Since $s^p = \frac{\Omega}{1+r}$,

$$\begin{aligned} U_2 &= \ln(w - \frac{\Omega}{1+r}) + \beta p \ln\left(\delta + \frac{h^p}{a}\right) + \beta \ln(\Omega) \qquad (4.17) \\ &\equiv U_2\left(w, \Omega; \beta, \delta, p, r\right) \end{aligned}$$

For individuals that save more than $s^p$ there is no access to government funded healthcare so $h$ has to be personally financed. The individual optimizes by choosing both $h$ and $s$ . The indirect utility function $U_3$ is then defined by

$$U_3 = \ln(w - s) + \beta p \ln\left((\delta + \frac{h}{a})((1+r)s - h)\right) + \beta(1-p)\ln\left((1+r)s\right)$$

$$\max_{\{h,s\}} U_3 = \ln(w-s) + \beta p \ln(\delta + \frac{h}{a}) + \beta p \ln((1+r)s - h) + \beta(1-p)\ln((1+r)s). \tag{4.18}$$

The first-order conditions for $h$ and $s$ give

$$\begin{aligned} \frac{\partial U_3}{\partial s} &= -\frac{1}{w-s} + \frac{\beta p(1+r)}{(1+r)s - h} + \frac{\beta(1-p)}{s}, && (4.19) \\ \frac{\partial U_3}{\partial h} &= \frac{\beta p}{a(\delta + \frac{h}{a})} - \frac{\beta p}{(1+r)s - h}. && (4.20) \end{aligned}$$

These equations can be solved to give

$$\begin{aligned} h &= h(w;\beta,\delta,p,r), \\ s &= s(w;\beta,\delta,p,r). \end{aligned}$$

The indirect utility function can then be written

$$\begin{aligned} U_3 &= \ln(w - s(w;\beta,\delta,p,r)) + \beta p \ln(\delta + \frac{h(w;\beta,\delta,p,r)}{a}) \\ &\quad + \beta p \ln((1+r)s(w;\beta,\delta,p,r) - h(w;\beta,\delta,p,r)) + \beta(1-p)\ln((1+r)s(w;\beta,\delta,p,r)) \\ &\equiv U_3(w;\beta,\delta,p,r). \end{aligned} \tag{4.21}$$

These indirect utility functions permit the value of $w^*$ to be determined. $w^*$ is the income level at which an individual saves sufficiently over the government threshold and fails the means test, which also means this is the income level at which individuals determine that purchasing care is preferable to keeping saving artificially low. The value of $w^*$ is determined by the equality of $U_2$ and $U_3$

$$U_2\left(w^*, \Omega; \beta, \delta, p, r\right) = U_3(w^*; \beta, \delta, p, r). \tag{4.22}$$

The implications of these calculations are illustrated in the Figure 4.1. In the figure, $W$ indicates a person's wealth level in the second period of life,

$$\begin{aligned} W &= (1+r)s \\ s(w) &= \frac{W}{1+r} \end{aligned}$$

The first figure depicts the three indirect utility functions and the construction of the income level $w^*$. The second figure displays the path of saving. Individuals who have different level of savings can be categorized into three groups according to income level. Those with income $w \in [\underline{w}, w^p]$ pass the means test without having to restrict saving and receive the government healthcare $h^p$. Their savings as a function of $w$ follow path $s(w < w^p)$. At income level $w^p$ saving becomes constant at $s^p$ in order to ensure the means test is passed. It remains constant until income level $w^*$ is reached. This is the

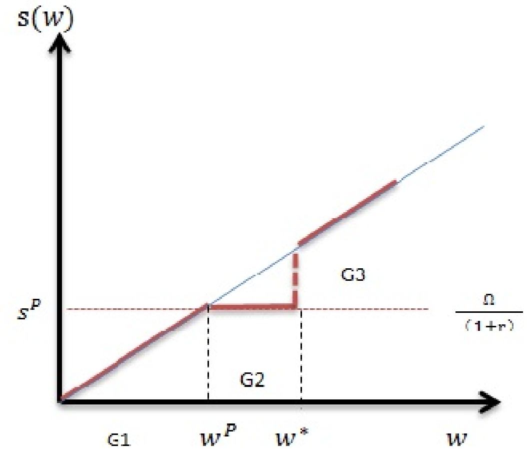


Figure 4.1: Saving behaviour under Policy Scheme 1

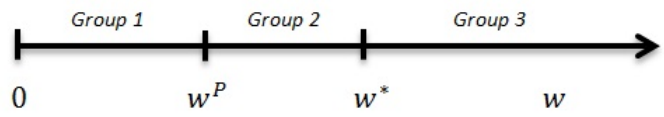


Figure 4.2: Groups of individuals under Policy Scheme 1

saving path $s(w^p < w < w^*)$. Once income level $w^*$ is exceeded the saving level line of this group of individuals becomes $s(w > w^*)$.

The three groups represent individuals who make different savings choices with consequences for the funding of long-term care spending. We assume the wage level in the economy ranges from $\underline{w}$ to $\overline{w}$. Social welfare consists of three different components representing the different indirect utlities. Social welfare level of this economy is given by

$$SW = \int_{\underline{w}}^{w^P} U_1(w)f(w)\,dw + \int_{w^p}^{w^*} U_2(w)f(w)\,dw + \int_{w^*}^{\overline{w}} U_3(w)f(w)\,dw. \tag{4.23}$$

Assuming that the individuals are distributed uniformly along the wage line, then

$$f(w) = \frac{1}{\overline{w} - \underline{w}}. \tag{4.24}$$

Using the indirect utility functions

Table 4.2: Variable list of social welfare of Scheme 1

| | |
|---|---|
| $w$ | Individuals' wages in the first period |
| $s$ | Individuals savings in the first period |
| $\beta$ | Discount factor in the second period |
| $p$ | Possibilities of the individuals getting health shocks in the second period of life |
| $h$ | Individuals' long-term care expenditure |
| $h^p$ | Personal allowance or individual subsidy of the means tested benefit |
| $a$ | A constant set to be large enough to make $\delta + \frac{h}{a} < 1$ |
| $\underline{w}$ | Lowest wage level in the population |
| $\overline{w}$ | Highest wage level in the population |
| $w^p$ | The critical point of income between Group1 and Group 2 |
| $w^*$ | The critical point of income between Group2 and Group3 |

$$\begin{aligned} SW &= \frac{1}{\overline{w}-\underline{w}}\left[\int_{\underline{w}}^{w^P}\left(\ln(w-s)+\beta p\ln\left(\delta+\frac{h^p}{a}\right)+\beta\ln((1+r)s)\right)dw\right. \\ &\quad +\int_{w^p}^{w^*}\left(\ln(w-s^p)+\beta p\ln\left(\delta+\frac{h^p}{a}\right)+\beta\ln((1+r)s^p)\right)dw \\ &\quad \left.+\int_{w^*}^{\overline{w}}\left(\ln(w-s)+\beta p\ln(\delta+\frac{h}{a})+\beta p\ln((1+r)s-h)+\beta(1-p)\ln((1+r)s)\right)dw\right]. \end{aligned} \tag{4.25}$$

This social welfare function is used to evaluate the alternative policies.

For any government policy $\{\boldsymbol{\Omega}, h^p\}$ , the cost of that policy in terms of public provisions of LTC is

$$k = \left(\frac{1}{\overline{w}-\underline{w}}\right)(w^*-\underline{w})h^p. \tag{4.26}$$

Alternative policies are evaluated taking this cost into account.

Through this section, three different individual choices under the no top-up scheme are analysed, and based on these, a social welfare function has been produced. The next section will explore the case under the top-up LTC policy scheme.

## 4.5 Individual Choice Under Different Saving Behaviour - Scheme 2

Scheme 2 permits individuals below the cut-off to top up the long-term care provided by the government. The government provides public provisions $h^p$ to eligible individuals with wealth less than $\Omega$. Eligible individuals can choose to make expenditure to increase LTC provisions to $h^p + h^t$, where $h^t \geq 0$. The key question is whether individuals under the threshold will choose to purchase a top-up and pay for extra care from their own resources.

For people who have savings under the threshold $s^p$ and make the choice to top-up, the utility in the second period of the individual choice is

$$\ln\{(\delta + \frac{h^p + h^t}{a})c^h\}, \tag{4.27}$$

and the budget constraint is

$$c^h + h^t = (1 + r)\, s. \tag{4.28}$$

The point denoted by $w^{\sim}$ where $w^{\sim} < w^p$ is a wage level below which people benefit from public subsidies but do not have the option to top up. When individuals have an income level larger than this point and lower than the government threshold, which is $w^{\sim} < w < w^h$, they have an option and will choose to top up on the public provisions.

First let us describe the first type of people who do not have the option to top up, in which $w < w^{\sim}$ and $h^t = 0$. The level of utility for the individual is,

$$U_1 = \ln(w - s) + \beta p \ln\left((\delta + \frac{h^p}{a})(1 + r)s\right) + \beta(1 - p)\ln\left((1 + r)s\right). \tag{4.29}$$

$$\max_{\{s\}} U_1 = \ln(w-s) + \beta p \ln\left(\delta + \frac{h^p}{a}\right) + \beta \ln\left(s(1+r)\right). \tag{4.30}$$

This problem has the same solution as for the no top-up case.

$$\frac{\partial u_1}{\partial s} = -\frac{1}{w-s} + \frac{\beta}{s} \tag{4.31}$$

With $\frac{\partial u_1}{\partial s} = 0$, we have a function of $s$ under the first utility function,

$$s = \frac{\beta}{1+\beta} w,$$

If an individual chooses to top up the government long-term care, we now have the utility function of the second type of people.

$$\max_{\{h^t, s\}} U_2 = \ln(w-s) + \beta p \ln\left(\delta + \frac{h^p + h^t}{a}\right) + \beta p \ln\left((1+r)s - h^t\right) + \beta(1-p)\ln\left((1+r)s\right). \tag{4.32}$$

The first-order conditions for the choice of saving $s$ and top-up amounts $h^t$ are

$$\begin{aligned} \frac{\partial U_2}{\partial h^t} &= \frac{\beta p}{a(\delta + \frac{h^p + h^t}{a})} - \frac{\beta p}{s(1+r) - h^t}, \\ \frac{\partial U_2}{\partial s} &= -\frac{1}{w-s} + \frac{\beta p(1+r)}{s(1+r) - h^t} + \frac{\beta(1-p)}{s}. \end{aligned} \tag{4.33}$$

The necessary condition of $U_2$ regarding $h^t$ gives us

$$s = \frac{a\delta + h^p + 2h^t}{1+r} \tag{4.34}$$

Meanwhile, the first-order conditions can be solved to provide the solution

$$\begin{aligned} s &= s\left(w; \beta, \delta, h^p, r, p\right), \\ h^t &= h^t\left(w; \beta, \delta, h^p, r, p\right). \end{aligned}$$

The corresponding indirect utility is

$$U_2 = U_2\left(w; \beta, \delta, h^p, r, p\right). \tag{4.35}$$

People who are able to top up $h^t$ on public provision only exist when the their income, $w$ , in the first period of the individual choice is above a certain level $w^{\sim}$. Assume the matching saving level of $w^{\sim}$ is $s^{\sim}$. Define $w^{\sim}$ by the condition

$$h^t\left(w; \beta, \delta, h^p, r, p\right) > 0 \text{ if } w > w^{\sim}.$$

So people of the first type, whose utility function is represented by $U_1$, not only save under the government means-tested threshold $s^p$, but also save under the saving $s^{\sim}$, get a subsidy of $h^p$ and do not top up. The second type of individual, who saves over the point $s^{\sim}$, but is still under the point of $s^p$, is given the option of top-up and will choose to top up. $U_2$ shows the utility function of this type of person. The critical point of $U_1$ and $U_2$ is $w^{\sim}$ and $s^{\sim}$. It is important for us to know how $w^{\sim}$ is represented according to the utilities.

From the first-order condition of $U_2$ , we know the level of saving is

$$s = \frac{a\delta + h^p + 2h^t}{1+r}$$

and wealth is

$$W = a\delta + h^p + 2h^t \tag{4.36}$$

So, based on the range of $h^t$, $W$ becomes,

$$W = a\delta + h^p + 2\max\{0, h^t(w)\} \tag{4.37}$$

When $W \leqslant \Omega$

$$s(1+r) \leqslant \Omega$$

$$a\delta + h^p + 2\max\{0, h^t(w)\} \leqslant \Omega$$

If the qualified individuals choose to top-up, $h^t > 0$,

$$s = \frac{a\delta + h^p + 2h^t}{1+r}$$

If the qualified individuals do not top up, $h^t = 0$,

$$s = \frac{a\delta + h^p}{1+r}$$

From the first-order condition of $U_2$, we know $w = \frac{1+\beta}{\beta}s$, so, when $h^t = 0$,

$$w = (\frac{1+\beta}{\beta})(\frac{a\delta + h^p}{1+r}) \tag{4.38}$$

When $h^t > 0$,

$$w = (\frac{1+\beta}{\beta})(\frac{a\delta + h^p + 2h^t}{1+r}) \tag{4.39}$$

The critical point of wealth concerning whether people choose to top up is,

$$W = a\delta + h^p. \tag{4.40}$$

Under the government wealth threshold, when $W < a\delta + h^p$, individuals will not top up. But when $W > c\delta + h^p$, they will choose to top up and the spending of $h^t$ exists. When the wage level is smaller than $w = (\frac{1+\beta}{\beta})(\frac{a\delta+h^p}{1+r})$, individuals will not top up, hence

$$w^{\sim} = (\frac{1+\beta}{\beta})(\frac{a\delta + h^p}{1+r}) \tag{4.41}$$

$$s^{\sim} = \frac{a\delta + h^p}{1+r} \tag{4.42}$$

The third type of individuals are those whose savings reach the point of the government threshold, but have an incentive to spend more and save less to stay in the government's program. Until their incomes reach a point, denoted $w^*$, where the public provisions are not worth the extra consumption any more, they will change this behaviour. The level of savings for these people stays at $s^p$, and their uitlity is

$$\max U_3 = \ln(w - s^p) + \beta p \ln\left(\delta + \frac{h^p + \overline{h^t}}{a}\right) + \beta p \ln\left((1+r)s^p - \overline{h^t}\right) + \beta(1-p)\ln\left((1+r)s^p\right) \tag{4.43}$$

According to the previous calculations of $U_2$,

$$s = \frac{a\delta + h^p + 2h^t}{1+r}$$

The critical point between $U_2$ and $U_3$ provides that,

$$s^p = \frac{a\delta + h^p + 2\overline{h^t}}{1+r} \tag{4.44}$$

$$\overline{h^t} = \frac{\boldsymbol{\Omega} - a\delta - h^p}{2} \tag{4.45}$$

The utility function for the last type describes the group of people whose wealth level is above the government threshold, and who do not receive public provisions. Their spending of care is covered by themselves, and it is denoted by $h$. The utility function is the same as the individual choice.

$$\max_{\{h,s\}} U_4 = \ln(w - s) + \beta p \ln(\delta + \frac{h}{a}) + \beta p \ln((1+r)s - h) + \beta(1-p)\ln((1+r)s)$$

The saving behaviour of individuals affected by means-testing allowing top-up is shown below on the Figure 4.3,

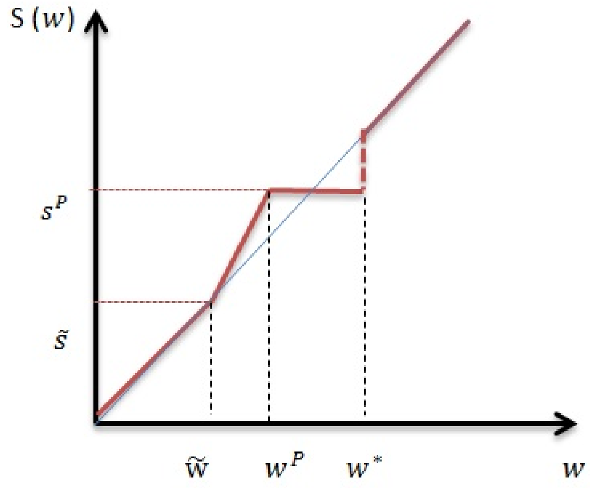


Figure 4.3: Saving behaviour under Policy Scheme 2

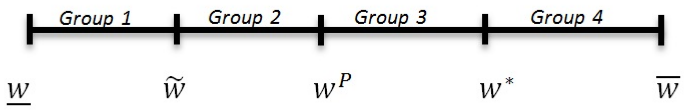


Figure 4.4: Groups of individuals under Policy Scheme 2

The economy allowing a top-up should be made up by four groups of individuals who have different choices. The Groups 1, 2, 3 and 4 have the utility function of $U_1$, $U_2$, $U_3$ and $U_4$.

$$
\begin{aligned}
U_1 &= \ln(w-s) + \beta p \ln(\delta + \frac{h^p}{a}) + \beta \ln(s(1+r)). \\
U_2 &= \ln(w-s) + \beta p \ln(\delta + \frac{h^p + h^t}{a}) + \beta p \ln\left((1+r)s - h^t\right) + \beta(1-p)\ln\left((1+r)s\right). \\
U_3 &= \ln(w-s^p) + \beta p \ln(\delta + \frac{h^p + \overline{h^t}}{a}) + \beta p \ln((1+r)s^p - \overline{h^t}) + \beta(1-p)\ln((1+r)s^p). \\
U_4 &= U_4 = \ln(w-s) + \beta p \ln(\delta + \frac{h}{a}) + \beta p \ln((1+r)s - h) + \beta(1-p)\ln((1+r)s).
\end{aligned}
$$

Table 4.3: Variable list of social welfare of Scheme 2

| | |
|---|---|
| $w$ | Individuals' wages in the first period |
| $s$ | Individuals' savings in the first period |
| $\beta$ | Discount factor |
| $p$ | Possibilities of the individuals getting health shocks in the second period of life |
| $h$ | Individuals' long-term care expenditure |
| $h^p$ | Personal allowance or individual subsidy in a means-tested benefit |
| $h^t$ | Top-up payments from the benefit recipients on top of $h^p$ |
| $\overline{h^t}$ | The maximum top-up payments recipients will pay |
| $a$ | A constant set to be large enough to make $\delta + \frac{h}{a} < 1$ |
| $\underline{w}$ | Lowest wage level in the population |
| $\overline{w}$ | Highest wage level in the population |
| $w^\sim$ | Critical point of income between Group 1 and Group 2 |
| $w^p$ | Critical point of income between Group 2 and Group 3 |
| $w^*$ | Critical point of income between Group 3 and Group 4 |

$$\begin{aligned} SW &= \frac{1}{\overline{w}-\underline{w}}[\int_{\underline{w}}^{w^\sim}(\ln(w-s)+\beta p\ln(\delta+\frac{h^p}{a})+\beta\ln(s(1+r)))dw \\ &+\int_{w^\sim}^{w^p}(\ln(w-s)+\beta p\ln(\delta+\frac{h^p+h^t}{a})+\beta p\ln((1+r)s-h^t)+\beta(1-p)\ln((1+r)s))dw \\ &+\int_{w^p}^{w^*}(\ln(w-s^p)+\beta p\ln(\delta+\frac{h^p+\overline{h^t}}{a})+\beta p\ln((1+r)s^p-\overline{h^t})+\beta(1-p)\ln((1+r)s^p))dw \\ &+\int_{w^*}^{\overline{w}}(\ln(w-s)+\beta p\ln(\delta+\frac{h}{a})+\beta p\ln((1+r)s-h)+\beta(1-p)\ln((1+r)s))dw]. \end{aligned} \tag{4.46}$$

Under this LTC public means-tested policy, a top-up is allowed, and it has four individual choices forming four groups of people in the population. The next section will investigate these two schemes of LTC means-tested policies and examine how the factors affect each other and the economy.

## 4.6 Simulations

To understand the outcomes due to different factors changing in the means tests, we need to calibrate the models of the individual choices and the welfare functions under the two schemes. The idea here is that numbers will be set and put into the variables of possibilities of getting health shocks ($p$), interest rate ($r$), severity of the health shocks ($\delta$), time factor ($\beta$), constant ($a$), the lowest income in the population ($\underline{w}$), the highest income in the population ($\overline{w}$), saving and wealth thresholds of the means test ($s^p, \Omega$) and public provision of LTC for each individual ($h^p$).

Then the level of groups' dividers of $w^p$ and $w^*$ in Scheme 1, $w^\sim$, $w^p$ and $w^*$ in Scheme 2, the aggregate cost of LTC policy $k$, and the social welfare level $SW$ can be calculated. By changing the individual subsidy or personal allowance $h^p$ or the benefit threshold $\Omega$ and $s^p$, we can find out how $w^\sim$, $w^p, w^*$ and $SW$ change as well.

With the respect of the preference parameters that are set fixed through the simulations in this paper, we set the possibilities of getting health shocks to $25\%$, the interest rate $r$ to $0.2$, the parameter of severity of health shocks $\delta$ to $0.25$, the discount factor $\beta$ to $0.4$, the lowest income to $0$, the highest income to $100$, and finally the constant $a$ to $30$. It is worth mentioning that the intention of introducing the constant $a$ into the model is not only to include the factor of severity $\delta$, but also to express the idea that $\frac{h}{a} < 1$, where h cannot exceed $a$ although more spending on LTC may generate higher utility ( $\frac{h}{a}$ will increase) but it can never recover to the original status ( $\frac{h}{a} = 1$). Mean while, including the consideration of severity $\delta$, $\delta + \frac{h}{a} < 1$. Under this set of number $a = 30$, and $\delta = 0.25$, $h$ needs to be in the range of $0$ to $22.5$.

$$p = 0.25, r = 0.2, \delta = 0.25, \beta = 0.4, a = 30, \underline{w} = 0, \overline{w} = 100 \tag{4.47}$$

### 4.6.1 Simulations of Scheme 1

The following results demonstrate simulations under three such conditions. The simulation in Table 4.4 shows what happens when government increases the public provisions of each individual ($h^p$), while the means test threshold of personal savings ($s^p$) and wealth ($\Omega$) are kept unchanged. Table 4.5 gives a simulation in which the level of individual benefit subsidy ($h^p$) remains constant while the means test threshold changes. Another

Table 4.4: Calibration of Scheme 1 - Change of $h^p$

| $\Omega$ | $h^p$ | $s^p$ | $w^p$ | $w^*$ | $k$ | $SW$ | $w^* - w^p$ |
|---|---|---|---|---|---|---|---|
| 3.6 | 5.0 | 3.0 | 10.5 | 16.8931 | 0.8447 | 4.1147 | 6.3931 |
| 3.6 | 6.0 | 3.0 | 10.5 | 17.6450 | 1.0588 | 4.1161 | 7.1450 |
| 3.6 | 7.0 | 3.0 | 10.5 | 18.3249 | 1.2827 | 4.1173 | 7.8249 |
| 3.6 | 8.0 | 3.0 | 10.5 | 18.9485 | 1.5159 | 4.1186 | 8.4485 |
| 3.6 | 9.0 | 3.0 | 10.5 | 19.5263 | 1.7574 | 4.1198 | 9.0263 |

simulation is put into Table 4.6, and it shows how the variables change if the government tries to keep the aggregate cost of the policy ($k$) fixed. In this case, both of the means test threshold and level of public provisions change.

In the first simulation, as shown in Table 4.4, the means test threshold of personal savings $s^p$ is set to be $s^p = 3.0$, so that $\Omega = (1 + r)s^p = 3.6$. The range of $h^p$ that used in the calibration is $(5.0, 6.0, ..., 9.0)$.

While keeping other variables unchanged, when the personal allowance of the LTC benefit $h^p$ increases, the critical point of Group 1 and Group 2 $w^p$ is not affected, but the critical point of Group 2 and Group 3 $w^*$ increases, and the cost of the LTC benefit policy $k$ shows an increase, as well as the social welfare level $SW$. The constant of $w^p$ and the increase of $w^*$ means that the size of Group 1 does not change, but the size of Group 2 expands. When the government improves the government provisions for each individual under the unchanged means test threshold, some people are likely to increase their daily consumption and have less savings to be on the threshold to get qualified to the public provisions, instead of paying LTC using their own finance. As more people pass the means test and join the government programmes, the cost of this policy increases. Although the increase in the population of Group 2 indicates an increasing dependency people develop for the social benefit system, the social welfare in this simulation still increases. Although normally if people talk about increasing the coverage of public provisions, they think of increasing factor like means-tested threshold directly, this table demonstrates that the change IN the level of personal allowance also affects the coverage to some level.

Table 4.5: Calibration of Scheme 1 - Change of $\Omega$ and $s^p$

| $\Omega$ | $h^p$ | $s^p$ | $w^p$ | $w^*$ | $k$ | $SW$ | $w^* - w^p$ |
|---|---|---|---|---|---|---|---|
| 1.8 | 5.0 | 1.5 | 5.25 | 6.7650 | 0.3382 | 4.1409 | 1.5150 |
| 2.4 | 5.0 | 2.0 | 7.00 | 10.4694 | 0.5235 | 4.1319 | 3.4694 |
| 3.0 | 5.0 | 2.5 | 8.75 | 13.7703 | 0.6885 | 4.1232 | 5.0203 |
| 3.6 | 5.0 | 3.0 | 10.50 | 16.8931 | 0.8447 | 4.1147 | 6.3931 |
| 4.2 | 5.0 | 3.5 | 12.25 | 19.8773 | 0.9939 | 4.1063 | 7.6273 |

Table 4.6: Calibration of Scheme 1 - Constant $k$

| $\Omega$ | $h^p$ | $s^p$ | $w^p$ | $w^*$ | $k$ | $SW$ | $w^* - w^p$ |
|---|---|---|---|---|---|---|---|
| 3.0000 | 5.0 | 3.0000 | 8.7500 | 13.7703 | 0.6885 | 4.1232 | 5.0203 |
| 2.4680 | 6.0 | 2.0567 | 7.1983 | 11.4747 | 0.6885 | 4.1218 | 4.2764 |
| 2.1001 | 7.0 | 1.7501 | 6.1253 | 9.8357 | 0.6885 | 4.1377 | 3.7104 |
| 1.8300 | 8.0 | 1.5250 | 5.3375 | 8.6061 | 0.6885 | 4.1424 | 3.2686 |
| 1.6231 | 9.0 | 1.3526 | 4.7340 | 7.6501 | 0.6885 | 4.145 | 2.9161 |

The case where the level of government subsidy is held constant and the level of the means test threshold is raised is shown in Table 4.5. The value of $h^p$ is kept at $5.0$, values of $s^p$ are $1.5, 2.0, ...,$ and $3.5$, where matching $\Omega$ can be calculated.

Increasing the means test threshold can adjust the people that the benefit targets at, thus a direct influence to create a wider coverage of the public provisions is foreseeable. The government benefit policy becoming more accessible is reflected in the increase in the group dividers $w^p$ and $w^*$. This indicates that if the means test threshold of this public policy increases, more people with higher income and more savings will join the first two groups and get qualified for the government provisions. Both Group 1 and 2 will expand, but the size of Group 2 will grow faster. The size of Group 3 will shrink quite rapidly. The cost of the policy $k$ will increase as expected, but the social welfare $SW$ will decrease.

How government policy $(\Omega, h^p)$ changes under a constant cost is tested and the simulation results are shown in Table 4.6. The value of $h^p$ is put in first following which the value of $\Omega$ that keeps $k$ constant is searched. The policies $(3.0, 5.0)$, $(2.4680, 6.0)$, $(2.1001, 7.0)$, $(1.8300, 8.0)$ and $(1.6231, 9.0)$ can generate the same cost that $k = 0.6885$.

The results suggest that, keeping the cost of policy $k$ constant, a lower $\Omega$ and higher $h^p$

generates smaller values of $w^p$ and $w^*$, and higher values of $SW$.

This indicates that when government issues a policy on covering an individual's long-term care cost under a constant budget, a lower means test threshold and a higher amounts of subsidy will shrink the size of Group 1 and Group 2 and make less people stay under the programme. As a result, this condition can achieve a higher social welfare level. To only pursue a wider coverage of public policies can not increase the social welfare. Instead, public policies with clear targeting of individuals with lower or the lowest income can bring higher social welfare in Scheme 1.

In conclusion, under a means-tested regime not allowing any top-up, the population is categorized in three groups, in which the first group saves under the means test benefit threshold, the second group saves on the means test threshold, and the third group saves above the government threshold. The government pays for the LTC spending for the first two groups. This section shows that, when the individual subsidy increases while other parameters are kept unchanged, social welfare level increases even though the number of people in Group 1 is unchanged and that of Group 2 increases. When this regime faces an increasing benefit threshold but constant individual subsidies, the sizes of Group 1 and 2 both increase, and the social welfare level decreases. Under a constant budget of policy cost, it is a lower means test threshold and a higher personal allowance that can generate higher social welfare. In other words, to achieve a higher social welfare level in the policy regime 1, instead of increasing the benefit coverage, the government should focus on providing more targeted services, and the more the government provides to people who are most in need, the higher the social welfare that it will have. Using this approach also creates minimum dependency from the recipients to the benefit system.

### 4.6.2 Simulations of Scheme 2

Scheme 2 allows individuals to top up on the existing public provisions if they pass the means test. Different from the population structure from Scheme 1, this scheme has an extra group of people whose long-term care spending is only partly covered by the government, and partly paid for by the recipients themselves through a top-up. $h^t$ is the amounts that are topped up. As calculated in the previous section,

$$s = \frac{a\delta + h^p + 2h^t}{1+r}$$

To make $h^t > 0$ when $s < s^p$, the calibration has to satisfy the condition that,

$$\begin{aligned} s &> \frac{h^p + a\delta}{1+r} \\ W &> h^p + a\delta \end{aligned}$$

When $s = s^p$, and $h^t = \overline{h^t}$, to make $\overline{h^t} > 0$, it has to satisfy that,

$$\begin{aligned} s^p &> \frac{h^p + a\delta}{1+r} \\ \Omega &> h^p + a \end{aligned}$$

The calibrated parameters that are kept constant in the simulations are

$$p = 0.25, r = 0.2, \delta = 0.25, \beta = 0.4, a = 30, \underline{w} = 0, \overline{w} = 100$$

As different constraints for the values of $s^p$ and $\Omega$ are applied in Scheme 2, the values substituted into them are quite different.

The first simulation in Table 4.7 shows the effects of changing $h^p$ while holding the means-tested thresholds $\Omega$ and $s^p$ unchanged. The values of $\Omega$ is set to $20.4$, which makes the values of $s^p$ as $17.0$. The numbers substituted into $h^p$ are $(3, 4, ..7)$. The critical point

Table 4.7: Calibration of Scheme 2 - Change of $h^p$

| $\boldsymbol{\Omega}$ | $h^p$ | $\boldsymbol{s}^p$ | $\overline{h^t}$ | $w^{\sim}$ | $\boldsymbol{w}^p$ | $w^*$ | $k$ | $SW$ | $w^p - w\sim$ | $w^* - w^p$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 20.4 | 3.0 | 17.0 | 4.9500 | 43.7500 | 56.3499 | 71.6204 | 2.1486 | 3.9428 | 12.5999 | 15.2705 |
| 20.4 | 4.0 | 17.0 | 4.4500 | 46.6667 | 56.7299 | 74.6413 | 2.9857 | 3.9326 | 10.0632 | 17.9114 |
| 20.4 | 5.0 | 17.0 | 3.9500 | 49.5833 | 57.0954 | 77.3952 | 3.8698 | 3.9223 | 7.5172 | 20.3358 |
| 20.4 | 6.0 | 17.0 | 3.4500 | 52.5000 | 57.4408 | 79.9555 | 4.7973 | 3.9118 | 4.9408 | 22.5147 |
| 20.4 | 7.0 | 17.0 | 2.9500 | 55.4167 | 57.7781 | 82.3662 | 5.7656 | 3.9011 | 2.3614 | 24.5881 |

Table 4.8: Calibration of Scheme 2 - Change of $\Omega$ and $s^p$

| $\boldsymbol{\Omega}$ | $h^p$ | $\boldsymbol{s}^p$ | $\overline{h^t}$ | $w^{\sim}$ | $w^p$ | $w^*$ | $\boldsymbol{k}$ | $\boldsymbol{SW}$ | $w^p - w\sim$ | $w^* - w^p$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 18.0 | 5.0 | 15.0 | 2.75 | 49.5833 | 50.8810 | 70.0350 | 3.5018 | 3.9203 | 1.2977 | 19.1540 |
| 18.6 | 5.0 | 15.5 | 3.05 | 49.5833 | 52.4372 | 71.8861 | 3.5943 | 3.9208 | 2.8539 | 19.4489 |
| 19.2 | 5.0 | 16.0 | 3.35 | 49.5833 | 53.9945 | 73.7296 | 3.6865 | 3.9213 | 4.4112 | 19.7351 |
| 19.8 | 5.0 | 16.5 | 3.65 | 49.5833 | 55.5529 | 75.5658 | 3.7783 | 3.9218 | 5.9696 | 20.0129 |
| 20.4 | 5.0 | 17.0 | 3.95 | 49.5833 | 57.0954 | 77.3952 | 3.8698 | 3.9223 | 7.5121 | 20.2998 |

of Group 1 and Group 2 is $w^{\sim}$, and as calculated, $w^{\sim}$ is directly affected by the values of $h^p$. The results suggest that when the government increases personal allowance for the benefit recipients, all the values of critical points between groups rise. Although the extent of the increases varies, it still shows the result of more people joining the program; as individual subsidy increases, thus the aggregate cost of the policy $k$ increases.

Through the calculations of $w^{\sim} - 0$, $w^p - w \sim$, $w^* - w^p$, and $100 - w^*$, we can have estimations of the sizes of the four groups of people in the economy. As $h^p$ increases, the rise of $w^{\sim}$ makes the size of Group 1 expand. However, Group 2 shrinks. We can also observe that the maximum top-up pay-out $\overline{h^t}$ reduces. This shows that as the government adds more individual subsidy, it relieves the pressure on the individual's LTC spending. For some people in Group 2, it is no longer necessary to make the extra top-up to meet their personal LTC needs, so more people join Group 1. The size of Group 3 increases, and more people have the incentives to save less to get qualified for the public provisions, and as a result, more people shift from Group 4 to Group 3. People show an increasing dependency on the benefit. The social welfare decreases in this simulation.

The second simulation (Table 4.8) is regarding the government increasing the means test threshold $\Omega$ or $s^p$ when other parameters especially the personal allowance $h^p$ are

Table 4.9: Calibration of Scheme 2 - Constant $k$

| $k$ | $\Omega$ | $h^p$ | $s^p$ | $\overline{h^t}$ | $w^\sim$ | $w^p$ | $w^*$ | $SW$ | $w^p - w\sim$ | $w^* - w^p$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 3.58 | 21.6 | 4.5 | 18.00 | 4.80 | 48.1250 | 60.0024 | 79.6522 | 3.9283 | 11.8774 | 19.6498 |
| 3.58 | 20.9 | 4.6 | 17.42 | 4.40 | 48.4167 | 58.2386 | 77.8283 | 3.9268 | 9.8219 | 19.5897 |
| 3.58 | 20.3 | 4.7 | 16.92 | 4.05 | 48.7083 | 57.2424 | 76.2892 | 3.9253 | 8.5341 | 19.5468 |
| 3.58 | 19.7 | 4.8 | 16.42 | 3.70 | 49.0000 | 55.2173 | 74.7347 | 3.9238 | 6.2173 | 19.5174 |
| 3.58 | 19.1 | 4.9 | 15.92 | 3.35 | 49.2917 | 53.6984 | 73.1645 | 3.9220 | 4.4067 | 19.4661 |

held constant. The sets of $s^p$ and $\Omega$ that are substituted into the simulations are $s^p \in (15, 15.5, .., 17)$ and $\Omega \in (18, 18.6, .., 20.4)$.

The increase of $w^*$ indicates that the population joining the benefit programmes increases and less people are paying for LTC cost entirely using their own finance. But the changes in the sizes of the groups are different. Group 1 keeps unchanged while the threshold of the means test increases. Both Group 2 and 3 expand, but the magnitude of the increase in the size of Group 2 is significant, and that of the size of Group 3 is quite small. The cost of the policy increases, as well as the social welfare. Although there are increasing numbers of people receiving benefits in both situations, the increase of the means-test threshold in Scheme 2 relatively creates less dependency on the system. More people finance the LTC spending with a combination of public provisions and their own money. Although Tables 4.7 and 4.8 both show an increase in the cost of the policy for the government, the case where increasing the means-tested threshold can achieve a higher social welfare.

When the government cost of the LTC means-tested benefit $k$ is kept unchanged (Table 4.9), the parameters of the policy $(\Omega, h^p)$ are set as $(21.6, 4.5)$, $(20.9, 4.6)$, $(20.3, 4.7)$, $(19.7, 4.8)$ and $(19.1, 4.9)$. Scheme 2 shows a reversing result from Scheme 1, and it is a higher government threshold and a lower individual subsidy that can generate higher social welfare. It also brings a downsizing Group 1, an expanding Group 2 and 3, and a shrinking Group 4. The table also shows that the scope of increase of Group 2 is bigger than that of Group 3.

Under the regime in which top-up is an option, it has quite different results from the first

Table 4.10: Calibration of Scheme 1 and Scheme 2

| $\Omega$ | $h^p$ | $w_1^p$ | $w_1^*$ | $k_1$ | $SW_1$ | $w_2^p$ | $w_2^*$ | $k_2$ | $SW_2$ |
|---|---|---|---|---|---|---|---|---|---|
| 20.4 | 3.0 | 59.5000 | 67.6796 | 1.9704 | 3.8541 | 56.3499 | 71.6204 | 2.1486 | 3.9428 |
| 20.4 | 4.0 | 59.5000 | 70.7542 | 2.8302 | 3.8603 | 56.7299 | 74.6413 | 2.9857 | 3.9326 |
| 20.4 | 5.0 | 59.5000 | 74.7486 | 3.7374 | 3.8663 | 57.0954 | 77.3952 | 3.8698 | 3.9223 |
| 18.0 | 5.0 | 52.5000 | 68.7571 | 3.4379 | 3.9036 | 50.8810 | 70.0350 | 3.5018 | 3.9203 |
| 18.6 | 5.0 | 54.2500 | 70.3135 | 3.5157 | 3.8943 | 52.4372 | 71.8861 | 3.5943 | 3.9208 |
| 19.2 | 5.0 | 56.0000 | 71.8310 | 3.5915 | 3.8850 | 53.9945 | 73.7296 | 3.6865 | 3.9213 |

scheme. Scheme 2 results in four types of groups in the population. The first group does not have extra savings to pay on top of the public provisions, so the payment for LTC spending is entirely financed by the government. The second group saves above an invisible saving threshold but under the government means-tested threshold, where the individuals of this group have the ability to top up on the given subsidies. The third group grows some dependency on the system and saves on the means test threshold, and still has some LTC spending paid by the government. The fourth group saves above the threshold and pays for the LTC by themselves. The simulations have shown that an increase in just the personal allowance shows an increase in Group 1 and 3, and a decrease in Group 2 and 4. The group that has to be financed entirely by the government expands, and the number of people depending on the benefit system increases. The social welfare decreases in this case. If the benefit threshold is raised, and the personal allowance is kept unchanged, the size of Group 1 in which people have to depend entirely on the government is unchanged. The sizes of Groups 2 and 4 increase. The number of people in Group 3 decreases. That is, more people join the group whose LTC spending is financed by both the government and themselves. This change in Regime 2 also shows a decreasing dependency from the individuals on the government's benefit system. Under a constant budget, it is a higher means-testing threshold and a lower personal subsidy that can bring higher social welfare.

### 4.6.3 Comparison

To compare Schemes 1 and 2, different sets of $(\Omega, h^p)$ are substituted synchronously into both schemes. When the personal allowance of the means-tested policy $h^p$ is held constant, the increase of the benefit threshold $\Omega$ and $s^p$ causes a decrease in social welfare level of Scheme 1 but an increase of that of Scheme 2. On the other hand, when the means test threshold is kept unchanged, the increase of personal allowance brings an increase in the social welfare level in Scheme 1 but a decrease in Scheme 2. The directions of the change in social welfare for the two schemes are quite different if the parameters of means-tested policies change. This is due to the structures of the population for the two schemes being quite different. However, the table shows that Scheme 2 always generates a higher social welfare level. Although when we just increase individual subsidy in the benefit policy, the social welfare of Scheme 1 increases while that of Scheme 2 reduces, the social welfare level of Scheme 2 is still higher than that of Scheme 1, within the constraints of the calibrations. The critical point $w^*$ is also higher in Scheme 2. The top-up option allows more people to get public provisions under the same cost.

Comparing the changes of the groups in the population, for Scheme 1, whether a rise in the level of subsidy or the benefit while keeping the other one fixed will expand Group 2. Although the increase in subsidy generates a higher social welfare, both ways can increase the dependency on social benefits. When the policy cost is kept constant, a reducing policy threshold and an increasing individual subsidy in the means test can decrease the number of members in both Groups 1 and 2 and reduce the dependency on the benefits from people. The social welfare level also grows under such condition. When the simulations are run in Scheme 2, the increase in individual subsidy while the benefit threshold is constant makes Group 3 expand and the social welfare decrease. When the benefit threshold is kept unchanged, and the individual subsidy rises, the size of Group 3 decreases and the social welfare increases. The dependency on the benefit system is more likely to develop when we just increase individual subsidy in Scheme 2. When the cost of the policy is kept unchanged a higher social welfare can be generated when the benefit threshold increases and the individual subsidy decreases. But the number of people in Group 3 increases, which shows the increasing dependency on the benefits policy.

Comparing between Scheme 1 and 2, the means test allowing a top-up can bring a higher social benefit, and have a wider coverage of recipients at the same time. But meanwhile, Scheme 2 brings a higher policy cost. The intuition behind this result is that a regime with a top-up option allows not only whose income is below the lowest threshold, but also a group of people in a higher tier to be qualified to the government benefit on LTC. Thus the coverage is higher in this scheme. Meanwhile, this scheme motivates more spending on LTC services in the whole society. Along with this change, the cost of LTC and the social welfare of the society also becomes higher.

## 4.7 Conclusion

This paper has analyzed how the different means-tested LTC benefits affect individuals' saving behaviour and the whole economy in order to have an insightful understanding of the means-tested benefit design. A theoretical demonstration has been made based on a two-period life-cycle individual choice model considering the personal savings and a future uncertain LTC spending. By analyzing and developing different utility functions for different types of individuals under the economy, social welfare levels of the economy were presented. Compared with previous literature, we managed to study LTC spending under different means-tested policies. Through calibrations and the change in parameters, the changes in social welfare level of different means-tested policies were tested, and the changes in each type of population were analyzed. This study cannot only help to shape a direction to find the optimal means test design for social benefits, but also benefit us into testing the dependency that the recipients have on the welfare system.

Two schemes of means test design of LTC benefits were modeled and calibrated. The calibrations of the two means-tested policies show results with great differences. The reasons are that the changes of policy design generate different motivations for the population to save or consume. Thus some behaviour of the individuals change and create different types of groups, resulting in different structures in the population. The directions of change among groups are quite different, resulting in a different result on an aggregate level. Thus it is necessary to test the design of means-tested policies separately and specifically.

This paper has shown that when adopting a means test regime not allowing top-up, when a government wants to raise the individuals subsidy under an unchanged benefit threshold, the social welfare level increases although there may be some dependency that develops. When this regime faces an increasing benefit threshold but a constant individual subsidy, the social welfare level decreases. If bearing a constant aggregate cost of the policy, a government should lower the benefit threshold and increase the individual subsidy to achieve a higher social welfare. That is, under Regime 1, the more the government provides for the poorest individuals, the higher social welfare that there will be.

Under the means-tested policy design which allows recipients to top up, raising the individual subsidy while other parameters are kept constant results in a decrease of the social welfare. Meanwhile, it causes an expansion of the people whose LTC cost is financed entirely by the government. The dependency on the benefit system also increases in this case. In this regime, an increase in the benefit threshold can make more people supported by both the government and themselves, and the dependency from the population on the benefit system decreases. This is also a design that the government can choose if it has a constant budget but wants to increase the coverage of the benefit. Keeping the aggregate cost of the policy unchanged, the government undertaking Scheme 2 should raise the benefit threshold in the means test and target at a wider crowd to be the recipients even if the personal allowance has to be lower.

Through a comparison of Scheme 1 and Scheme 2, we can find out, if under the same level of benefit threshold and individual subsidy, Scheme 2 not only covers more recipients but also has a higher social welfare. However, the choices between Scheme 1 and 2 have to be discussed specifically considering more factors concerning economy.

The debate about fairness and effectiveness on social welfare has been long. Facing the pressures of the budget, most governments cannot seek the maximization of both fairness and effectiveness. A pursuit of fairness does not necessarily mean the increase of effectiveness. The means test of Scheme 1 prefers effectiveness to fairness to achieve a higher social welfare. But for Scheme 2, it is the pursuit of fairness that can result in a higher social welfare. Different designs of means-tested policies require specific analysis of the actions that the government should take. In the process we can also find out that the increase of the dependency on the system sometimes is inevitable but it does not necessarily mean the decrease of social welfare.

Although this study has demonstrated a method to analyze means-tested benefit policy, and how the change in the policy affects individual behaviour and social welfare, it still neglects some issues in its design by assumption. One is that the benefit thresholds and individual subsidy of the means tests are given. If the tax factor or a model describing the government is considered, the research will have more insights for policymakers on the financing of the LTC cost. This study was constructed from the economic point of view. In the real world, whether an individual can become a benefit recipient is through more trivial appraisal of a person's care needs and wealth status. Rather than having a unitary standard, individual subsidies vary from the appraisal results. Despite the limitations, this study has achieved the construction and calibration of an economy with a means-tested benefit policy and examined economic social welfare levels considering long-term care cost. Our results should have important implications for public policy regarding means-tested benefit policy.

# Chapter 5

# The Targeting and Effectiveness of Disability Cash Benefits for Long-term Care in England

## 5.1 Introduction

Of all the problems an aging population brings, limited coverage of public provisions of long-term care is a concern for many individuals in different areas of the world. Many countries are striving to make policy reforms to provide better social care to meet the increasing and intensifying care demand, including the U.K. government.

In the U.K., the current social care system for older people with disabilities consists of two parts: means-tested care services arranged by local authorities; and non-means-tested cash benefits provided by the state.

Most of the public provided social services are run by local government through assessments of an individual's care needs and wealth level. The local authorities match a person's needs to the services available. The eligibility criteria, arrangements and overall care budget vary locally and are decided by local authorities. Although local governments sometimes work together with charities and voluntary organizations, the government has a finite budget to cover the overall care needs. Social services arranged by local authorities attract user charges depending on the users' financial means.

On the state level, care related benefits, including Attendance Allowance (AA) and Disability Living Allowance (DLA) are available for those who are aged 65 or older. Disability Living Allowance, according to the Department of Work and Pension (DWP), is a tax-free benefit for mentally or physically disabled people with needs of personal care or mobility problems. It is non means-tested and non contributory. It can be claimed initially only by people under the age of 65 but receipt of DLA can then be continued to past age 65 and there is no transfer of DLA claimants onto AA at age 65.A claim for DLA cannot be initiated after the age of 65 (Pudney, 2010).

Attendance Allowance is only provided for those who are aged 65 or older. The recipients need to take assessments and provide medical evidence to prove they have had care needs for at least half a year before they become eligible for this allowance unless the claimants are in fast track due to terminal illness. Attendance Allowance requires certain per-contributions but is non means-tested. Comparing to providing for lower-income people, AA and DLA focus more on the extent of a person's care needs.

Cash benefits are believed to have great advantages. They emphasize individuals' choices and bring great flexibility. Together with the format of direct provision of services from local authorities, the risk for disabled individuals is reduced by diversification (Hancock et al., 2009). However, there is an ongoing debate about the role of disability-related cash benefits as an element of the public programme. Wanless Social Care Review (2006) argues that the payment of disability-related universal benefits is becoming increasingly inefficient and difficult to justify as the size of the older, disabled population expands. The debate about the level, distribution and form of the public provisions never stops (Bound and Burkhauser 1999; McVicar 2008). OECD (2011) points out that current discussions on long-term care policies of England concentrates on providing personal care to those with the lowest income and capital. Moreover, some debates center on the reform of the social care system, with the possibility of diverting public resources from cash benefits to extended local provision of care services (Wanless 2006; Department of Health 2009).

Pudney (2010) proposes that the consequences of reform of the current system cannot be fully considered until the operation of the system is better understood. The fact is that in the actual process of assessing eligibility, the concepts of disability and need are hard to define and impossible to translate into an unambiguous set of formal eligibility rules, which implies inherently an uncertainty in its operation. It has been pointed out by the National Audit Office that the rules for deciding entitlement to these benefits are based on a range of subjective tests that require the decision-makers to reach conclusions based on the evidence available. Even similar cases can generate different interpretations (NAO 2001, p55). Thus it requires greater scope of judgment, from both claim decision-makers in assessing claims and from claimants in constructing the strongest possible case.

The underlying focus of these arguments is in fact the significance of effective targeting of the cash benefits in the social care system. This raises our research questions: Who are those targeted by the disability benefits AA and DLA? Whether the actual outcomes meet the original purpose? This paper aims to estimate the decisions' outcomes and test the relationships between the receipt of disability cash benefits and the features of the recipients. Through this, a better understanding can be developed of how disability cash benefits are distributed across different income and disability levels and how this pattern differs from the stated aims under the design of the system. This can provide insights for policy-makers to improve the design of the social system and make the public provisions more effective and efficient.

The studies on the receipt of disability related allowance and different individuals' characteristics are around socio-demographic characteristics, education or gender divides. Some of them also examine the receipt of different disability benefits in the U.K. In all western countries disability benefits are more often granted to the less educated part of the workforce than to those who are better off (Valset et al., 2007). Cutrona et al. (2008) found that free drug samples were given more frequently to uninsured and low-income people.

Back in 1991, in the study of the probability of receiving of Invalidity Benefit (IVB) and duration of IVB claims, Holmes et al. (1991) discovered that age and health factors are significant determinants. Areas of poor housing and high unemployment are more associated with the receipt of IVB and with longer claim durations. IVB was introduced by the government in the 1970s, and has gradually been replaced by Employment and

Support Allowance.

In the studies of the disability benefits in the U.K., Pudney wrote several working papers at Institute for Social and Economic Research (ISER) (Pudney, 2009; Pudney, 2010; Hancock et al., 2010; Hancock et al., 2013), one of which explores the relationship between disability and receipt of the Attendance Allowance using data from the Family Resources Survey (FRS). It indicates that despite AA being non-means-tested, it is implicitly income-targeting, and lower-income people have a higher probability of receiving it. Instead of expecting the chance of receiving higher-rate payment depending only on the extent of care needs, it also depends significantly on income, type of disability and age (Pudney, 2010).

This study is different from the previous work from the following reasons. It is based on the claim results of more comprehensive disability cash benefits, including both AA and DLA. The data of this paper used is from English Longitudinal Survey of Ageing. Thus the tests on AA and DLA focus more on the elderly. Among the factors that may affect the outcomes of the receipt of the benefits, the role of individuals' financial status is specifically examined. The variable of wealth is considered along with the variable income. The considerations of both variables make the analysis on financial status more completed. Looking into income and wealth as key features can not only help determine how the disability benefits are allocated, but also contribute to investigate the problems of income and wealth divide.

This study controlled more variables in the features of the recipients, one important new variable was long-term care cost. Analyzing the role of care cost with the receipt of disability benefits helps us to estimate directly individuals' financial burden caused by care needs. However, this leads to an important issue of endogeneity, which exists between the receipt of disability cash benefits and the variable of care cost. This concern of endogeneity should be raised in testing between disability or care-related benefits and individuals' care or health spending. But the literature does not really address this problem and solutions are rare. The consideration of endogeneity in this paper is another advance from the previous literature. We will use the method of the instrumental variable (IV) to solve the endogeneity. This process will enlighten the future research in this area.

The next section gives a thorough explanation of the methodology used for this study. Section Three defines the dataset, the details of variables and carries out some preliminary analysis. The fourth section reports on the endogeneity problem, instrumental variable and relevant results. The results and the analysis of the paper follow in the fifth section. A discussion is given in the sixth section. Finally, section seven draws conclusions.

## 5.2 Methodology

### 5.2.1 Probit Model

The main methodology this paper adopted was the probit model, which tests under what level of the independent variables the dependent variable is most likely to happen. That is, to find out what features of the participants led to them being more likely to receive disability benefits.

The dependent variable of the probit model had to be a binary variable, which in this paper was whether a person received disability benefits. The value of the variable being $0$ means this person did not receive any disability benefits, while $1$ means he or she received at least one disability benefit. The estimated probability of an observation claims any disability benefit is $p$. An increase or decrease in the independent variable makes the outcome of the dependent variable more or less likely to happen.

Assuming there is a latent variable $Y^*$ such that

$$Y^* = X\beta + \varepsilon, \varepsilon \sim (0, 1) \tag{5.1}$$

In the probit model, for dependent variable $y_i$ , we observe only

$$y_i = \begin{cases} 0, \text{if } y_i^* \leq 0 \\ 1, \text{if } y_i^* > 0 \end{cases} \tag{5.2}$$

So,

$$\Pr(y_i^* \leq 0 \mid x_i) = \Pr(y_i = 0 \mid x_i) = \Pr(\varepsilon_i \leq -x_i\beta) = \Phi(-x_i\beta) \tag{5.3}$$

$$\Pr(y_i = 1 \mid x_i) = 1 - \Phi(-x_i\beta) = \Phi(x_i\beta) \tag{5.4}$$

$\Phi(x'\beta)$ is the cumulative distribution function of the standard normal distribution in the model.

$$\Phi(x'\beta) = \int_{-\infty}^{x'\beta} \phi(z)dz \tag{5.5}$$

The coefficient $\beta$ estimates the relationship between the dependent variable and the independent variables and it is the sign of the coefficient that we should pay attention to. The number of the coefficient means the change in the z-score of probability that $Y = 1$ for each unit of increase of the independent variable. Thus, we also needed to test the marginal effects in the probit model. The marginal effects indicate the change in the probability of $Y = 1$ happening given a one-unit change in an independent variable . For the $j^{th}$ independent variable the marginal effects are

$$\partial Pr(Y = 1)/\partial x_j = \beta_j \phi(x'\beta) \tag{5.6}$$

The marginal effects depend not just on $\beta_j$ but on the value of $x_j$ and all other independent variables. The calculations used the approach of average marginal effects. This estimator was applied to the data using Stata software.

### 5.2.2 Instrumental Variable Probit Model

A concern arose during the estimation where long-term care cost and the receipt of disability benefits may have the problem of endogeneity as the causation may flow in both directions. Having care need and care spending drives people to claim disability benefits. But the benefits they receive can be used to pay for care. It has been argued in Pudney (2009) that the disability benefit AA is unlikely to have a significant causal impact on whether care is actually received, mainly based on the potential multiple usage of the benefit and the lack of quantitative reports. But it is natural for us to believe that care cost should be a necessary spending for people who suffer from disabilities no matter how they spend their benefits. The problem of endogeneity cannot be neglected. To solve this problem, instrumental variables (IV) which do not affect the dependent variable but only affect the endogenous variables needed to be found. The endogenous variables being considered are informal care cost and formal care cost. As the two forms of care are substitutive and have a very small correlation coefficient, the variables of Formal Care Cost (FCC) and Informal Care Cost (IFCC) were applied with different IV. The instrumental variables were the access to hospitals and the number of household members. The details of the variables will be discussed in the next section.

Using Newey's (1987) minimum chi-squared (two-step) estimator, we can apply the method of IV into probit model analysis. In general,this control function estimator first estimates the model of endogenous regressors as a function of instruments as the first stage, and the estimated endogenous variable from the first stage is put into the function with the dependent variable.

Consider endogenous regressors $y_{ki}$ and the dependent variable $y_{1i}$ ,

$$
\begin{aligned}
y_{ki} &= x_{1i}\Pi_{1k} + x_{2i}\Pi_{2k} + v_{ki} && (5.7)\\
y^*_{1i} &= y_{2i}\beta_1 + y_{3i}\beta_2 + ... + y_{(p+1)i}\beta_p + x_{1i}\gamma + u_i && (5.8)
\end{aligned}
$$

$i = 1, ..., N$, $y_{ki}$ where $k = 2, 3..., p+1$ is an endogenous variable, $x_{1i}$ is a vector of exogenous variables, $x_{2i}$ is a vector of additional instruments, and the equation for $y_{ki}$ is written in reduced form.

$\beta$ and $\gamma$ are structural parameters, and $\Pi_1$ and $\Pi_2$ are matrices of reduced-form parameters. The error items are of normal distribution. It is required that the number of instruments is equal to or larger than that of endogenous variables . One important assumption of this model is that ($u_i$, $v_i$), where $v_i = (v_{2i}, v_{3i}...v_{(p+1)i})$ is independent and identically distributed multivariate normal for all $i$. To apply the method of IV to the probit model, we only observe,

$$
y_{1i} = \begin{cases} 0, \text{if } y^*_{1i} \leq 0 \\ 1, \text{if } y^*_{1i} > 0 \end{cases} \tag{5.9}
$$

This process was carried out by Stata software with the command of IV probit. It is worth noting that the IV probit can only be applied to continuous endogenous variables,as the variables of Formal Care Cost and Informal Care Cost in our case.

## 5.3 Data and Variables

### 5.3.1 English Longitudinal Study of Ageing (ELSA)

The data in this paper was survey data from the English Longitudinal Study of Ageing (ELSA). ELSA is a resource of information on the health, social, wellbeing and economic circumstances of the English population aged 50 and older.

The data was acquired from ELSA Wave 6, more specifically, from the sections of health, income and assets and social care, which was collected in Year 2011 and 2012. The relevant data collection method used in ELSA was a main interview and telephone interviews. The core questionnaire was carried out by Computer Assisted Personal Interviewing (CAPI) in the homes of the participants. A proxy informant was allowed if the participant was unable (due to physical or mental illness) or unwilling to join the interview. Telephone interviews were also included in the survey if the participants refused to attend an interview.

Wave 6 conducted 10,601 main interviews, in which 5,685 were with those aged 65 and over. The response rate of the household contact in this wave was 89%. Observations with missing data were omitted during our data processing. Our sample was those 5,685 individuals who were over 65, but specific sample size of a different model is determined by being in that complete set of variables, so it varies slightly from models. Some of our variables were captured straight from the survey, while for other variables data needed to be tailored and processed. It is worthwhile to note that the data used directly from the dataset from ELSA was after imputation. Care cost and the income including benefits income were in weekly terms. Some of the data was collected at the benefit-unit level, and it was transformed into the individual level before use.

### 5.3.2 Variables

Income and wealth are indicators of the participants' financial status. Among the features of the recipients of disability benefits, they are the prime variables to look into. They were examined in the overall probit model first, and were divided into four equal sized groups and customized into ten dummy variables in the robustness tests.

Total income (TI) is the total after-tax weekly income of participants. It is the sum of the participant's employment income, self-employment income, total state pension income, total annuitised income and total asset income, in which total annuitised income includes private pension income and annuity income, and total asset income includes savings, bonds, house rents etc. Questions regarding each kind of income were asked directly but separately in the survey and with different time unit before imputations. Asset income was collected with the wealth data and was in benefit units.It was transformed into individual unit level when used by applying the variable of BU equivalence scale, which was provided by the database. The variable of total income used in the probit model takes a log format. To avoid the missing values when total income equals to 0, total income was applied with log function after plus 1. Due to the volume of income being large, the extra 1 unit was ignored. The variable of total income shown in the results section for probit model is in the name of log of total income (lnTI).

Net total wealth (NTW) was acquired from the ELSA dataset directly. It is the sum of savings, investments, physical wealth and housing wealth after financial debt and mortgage debt were deducted. As the user guide indicates, total savings refer to the money invested in ‘safe’ assets such as bank accounts, savings accounts and cash ISAs. Total investments include money invested on risky assets such as shares, bonds, stocks, shares ISAs and life insurance ISAs. Physical and house wealth being considered in the survey consists of 1 Houses, flats or holiday homes, including timeshares (except the current home) 2 Farm or Business Property (such as a shop, warehouse or garage) 3 land 4 Money owed by others 5 A trust 6 A covenant or inheritance 7 Other assets such as works of art or collectibles. The values of these were appraised using the market value. The debt that was generated through the purchase of houses is mortgage. The mortgage type, rate, how much left to pay and how many years to run were collected and imputed. Apart from mortgage, other financial debt including money owned in credit cards, overdrafts and other private debt also were taken into consideration. Log function was also applied to NTW before being inputted into the probit model (lnNTW).

Health factors are key official criteria and need to be controlled. The health variables that we considered emphasize the effects from self-evaluated health level and the needs of care. Specifically, they are self-rated health (SRH), ADL score(ADL), total formal care cost (TFCC) and total informal care cost (TIFCC).

SRH is an overall rate of the self-perceived level of health by the participants, implicitly including the considerations of both mental and physical health. The levels of SRH are 1. Poor 2. Fair 3. Good 4. Very good 5. Excellent, and this variable was transformed into five dummy variables.

The variable of ADL shows a score based on the number of daily living activities that the participants could not manage to do. This was an evaluation of their daily care needs, which is also an indicator of their disability level. The activities that were considered in this variable included activities of daily living (ADLs) and instrumental activities of daily living (IADL). ADLs focus on basic skills and one's ability to take care of one's own body. IADLs need more advanced skills and generally require the use of executive functions, social skills and more complex environmental interactions (Foti and Koketsu, 2013). There are a total of 15 daily living activities in this variable[1].

Care Section is included in the ELSA for the first time in Wave 6. In constructing the variables of TFCC and TIFCC, after categorizing the data of hours of help given by formal or informal care givers, different rates of hourly care cost were applied. But the differences in the volumes and the number of care receivers for TFCC and TIFCC were substantial. In the sample, $447$ participants had formal care cost,while $1,135$ people had informal care cost. To better capture their linear relationships with the dependent variable, log was applied to the variables of TFCC and TIFCC (lnTFCC and lnTIFCC).

In the probit model analysis, socio-demographic variables of age (Age), gender (Gender), marital status (MS), purchase of insurance (Insurance), hobby or pastime (Hobby) were

[1] ADLs include 1. Dressing, including putting on shoes and socks, 2 Walking across a room, 3 Bathing or showering, 4 Eating, such as cutting up food, 5 Getting in or out of bed, 6 Using the toilet, including getting up or down, 7 Using a map to figure out how to get around in a strange place, 8 Recognizing when you are in physical danger; IADLs refer to 9 Preparing a hot meal, 10 Shopping for groceries, 11 Making telephone calls, 12 Communication (speech, hearing or eyesight), 13 Taking medications, 14 Doing work around the house or garden, 15 Managing money, such as paying bills and keeping track of expenses. For more definitions and explanations, please refer to Foti and Koketsu (2013).

also controlled. The definitions and summary statistics of all the variables can be found in Appendix 1.

### 5.3.3 Data Description

To have a better understanding of the data, it was necessary to conduct some preliminary data analysis. Besides observing histograms to find out how the data was distributed, correlation coefficients were produced to measure the strength and direction of a linear relationship between two variables. The two-way table presents shares of participants who received or did not receive disability benefits of each variable. The histograms and table of correlation coefficients are in Appendices 2 and 3. The two-way table is presented below in Table 1.

**Income Variables**

The histograms of the variable total income and net total wealth (Appendix 2) all showed right-skewed distributions. Most people had an income level in the range of 0 to 500. The pillar with an approximate income level of 150 to 200 was the highest.

Suggested from correlation coefficients (Appendix 3), the variables of total income and total wealth had a moderate association with each other. Both variables of income and wealth had negative relationships with care cost, ADL Score and low rated health. Disability benefits had negative relationships with total income and net total wealth.

In the two-way table (Table 1), income and wealth variables were divided separately into four categories of every 25% weighted sample data. Of the first and second quarter of the sample who had lower income, 17% of the participants received disability benefits. In the third quarter of the data, the share of recipients was 11%. Only 7% of people received disability benefits in the last 25% of the sample. The probability of receiving disability benefits declined while the level of income increased. People with lower income were more likely to receive disability benefits. But the differences between the first two

Table 5.1: Two-way table analysis

| | RBD | |
|---|---|---|
| TI | 0 | 1 |
| 1(TI$\leq$ 139.78) | 83% | 17% |
| 2(139.78<TI$\leq$ 217.82) | 83% | 17% |
| 3(217.82<TI$\leq$ 349.72) | 89% | 11% |
| 4(TI>349.72) | 95% | 5% |
| NTW | | |
| 1(NTW$\leq$ 95,340) | 76% | 24% |
| 2(95,340<NTW$\leq$ 175,267) | 88% | 12% |
| 3(175,267<NTW$\leq$ 306,666) | 92% | 8% |
| 4(NTW>306,666) | 95% | 5% |
| ADL | | |
| 0 | 96% | 4% |
| 1 | 87% | 13% |
| 2 | 76% | 24% |
| 3 | 66% | 34% |
| 4 | 56% | 44% |
| 5 | 52% | 48% |
| 6 | 45% | 55% |
| 7 | 32% | 68% |
| 8 | 41% | 59% |
| 9 | 34% | 66% |
| 10 | 34% | 66% |
| 11 | 27% | 73% |
| 12 | 32% | 68% |
| 13 | 16% | 84% |
| 14 | 23% | 77% |
| 15 | 25% | 75% |
| SRH | | |
| SRH1 | 56% | 44% |
| SRH2 | 79% | 21% |
| SRH3 | 93% | 7% |
| SRH4 | 97% | 3% |
| SRH5 | 98% | 2% |
| TFCC | | |
| 0 (TFCC=0) | 89% | 11% |
| 1(TFCC>0) | 60% | 40% |
| TIFCC | | |
| 0 (TIFCC=0) | 92% | 8% |
| 1(TIFCC>0) | 61% | 39% |
| Age | | |
| 1 (65<Age$\leq$ 75) | 90% | 10% |
| 2 (75<Age$\leq$ 85) | 85% | 15% |
| 31 (Ag>85) | 69% | 31% |
| Gender | | |
| 0(Male) | 88% | 12% |
| 1(Female) | 85% | 15% |
| MS | | |
| 0 (not single) | 90% | 10% |
| 1 (single) | 80% | 20% |
| Insurance | | |
| 0(Insurance) | 92% | 8% |
| 1(No insurance) | 81% | 19% |
| Hobby | | |
| 0 (hobby) | 90% | 10% |
| 1(No hobby) | 86% | 14% |
| Total | 4896(86%) | 789(14%) |

quarters were not very significant, and it is not fair to draw the conclusion now that the lower income people have the more likely they are to receive disability benefits. Probit models had to be implemented not only in the whole sample but also in each equal-divided income group and among groups, under the circumstances that more variables were controlled.

The trend in the two-way table between net total wealth and the receipt of disability benefits was more distinctive. The weighting of the recipients of the four wealth groups declined quite rapidly to, 24%, 12%, 8% and 5%. This indicates that the groups who held less net total wealth had higher probabilities of receiving disability benefits. Similarly with the variable of income, the variable of wealth could not only be observed from the frequencies of dependent variable happening but needed to be implemented in and among groups with other variables controlled. This benefits us in understanding more about the criteria or subjective standards on individuals' financial status when giving out disability benefits.

**Health Variables**

Health variables are also significant variables in examining the relationships with the receipt of disability benefits. We assume that the individuals with more severe health problems are more likely to get disability benefits.

In the two-way table, self-rated health showed an obvious trend of decreasing proportions of the recipients of disability benefits. The ADL variable revealed that the shares of the recipients increased rapidly when the scores increased. Although the percentages had ups and downs, they increased on more than 50% after score 6 and over 70% after score 13. Generally, the two-way table showed that the worse the self-rated health was, or the higher the ADL scores were, the more likely people were to receive disability benefits.

The histograms of formal care cost and informal care cost showed that most of the care receivers had a weekly formal care cost under $\pounds 500$ and informal care cost under $\pounds 1200$.

Total informal care cost and total care cost had a very weak association, with the correlation coefficient being $0.07$, which showed that informal care and formal care were almost substitutive. For the participants $20\%$ had informal care cost while only nearly $8\%$ had formal care cost. This reflects the phenomenon that most people who are in need of care rely on informal care.

Suggested from the two-way table, among the people who had formal care cost, $40\%$ of them were recipients of disability benefits.This share was quite similar to the people who had informal care cost, where $39\%$ of them received disability benefits.

Individuals with relatively poor health and in need of care were more likely to receive disability benefits. This matches the expectations of the relationships between the dependent variable and the health variables.

**Other Variables**

Socio-demographic factors are important variables to be controlled. Three groups were formed in the variable of age to generate the two-way table. The first group contained participants who were over age 65 and under 75, and the second group was for those between 75 to 85, the third group was for the over 85 year olds. The proportions of people who received disability benefits of each age group were $9.1\%$, $8.7\%$ and $9.8\%$, which does not show a very distinctive trend.

The two-way table showed that more women received disability benefits. The proportions of recipients were $12\%$ for male and $15\%$ for female. It is worth noting that of the 5,685 participants, 3,066 were female and 2,619 were male. The data involved more women than men in the first place.

The marriage status is also a bivariate variable and has two groups. Although the proportions of disability benefits recipients were quite close, the number of participants who were in a married or civil partner situation were 3,643, and it was more than the number

Table 5.2: Instrumental variable analysis on endogenous variables

| lnTFCC | Coef. | Std.Err. | t | P>t | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| Ho1 | -0.993 | 0.168 | -5.93 | 0 | -1.322 | -0.665 |
| Ho2 | -0.958 | 0.167 | -5.74 | 0 | -1.285 | -0.631 |
| Ho3 | -1.026 | 0.168 | -6.10 | 0 | -1.356 | -0.696 |
| Ho4 | -0.521 | 0.173 | -3.01 | 0.003 | -0.860 | -0.182 |
| NOH | -0.057 | 0.024 | -2.35 | 0.019 | -0.104 | -0.009 |
| lnTIFCC | Coef. | Std. Err. | t | P>t | 95% Conf.Interval | |
| Ho1 | -0.605 | 0.268 | -2.26 | 0.024 | -1.130 | -0.080 |
| Ho2 | -0.588 | 0.267 | -2.2 | 0.028 | -1.111 | -0.065 |
| Ho3 | -0.358 | 0.269 | -1.33 | 0.183 | -0.886 | 0.169 |
| Ho4 | -0.404 | 0.276 | -1.46 | 0.144 | -0.946 | 0.138 |
| NOH | 0.101 | 0.039 | 2.6 | 0.009 | 0.025 | 0.177 |

Wald test of exogeneity chi square=1.24, p=0.5392

of people who were single, divorced or widowed, which was 2,642. The two-way table still shows $20\%$ of single, divorced or widowed participants received disability benefits, which was much higher than the other group and only 10% were recipients.

For the variable of insurance, $6.2\%$ of people in the group without personal health insurance were recipients of disability benefits. In the group where people had the insurance, the proportion was $9.3\%$.

The last variable is whether a person had a hobby (or pastime). The proportion of the group 0, who had any hobby or pastime, was $6.7\%$ and the proportion of the group 1, who did not have a hobby or pastime was $13.1\%$.

## 5.4 Endogeneity

We suspect that endogeneity exists between the receipt of disability benefits and care cost variables. Although the variable of Total Formal Care Cost and Total Informal Care Cost are correlated, their correlation coefficient is 0.0681 (Appendix 3 Table A2) which is very small. This means that the formal care cost and informal care cost is mostly substitutive. It is highly likely that they are affected by different instrumental variables.

Informal care is mainly carried out by relatives or cohabitants. The variable of informal care cost should have strong links with the number of household members. Meanwhile, the receipt of disability benefits is not affected by the status of the household constructions but only affected by the circumstances of the individual. So the instrumental variable for informal care is the number of households. The assumption is that, the more household members an individual has, he or she will have an increasing possibility to receive more informal care.

Formal care is mainly carried out by workers from formal institutions. The access to hospitals was chosen to be the instrumental variable of formal care cost. But how it affects the formal care is worth emphasising. As the survey data that we are using was from a private residence, formal care was not carried out in formal institutions but where the participants lived. When in need of formal care, the more accessible the hospital is, the less likely the participants require formal care in their homes. Thus the instrumental variable-access to hospitals should have a negative relationship with the variable of formal care cost. The access to hospitals has several levels, which are, very easy, quite easy, quite difficult, very difficult, and unable to go, and they were made into dummy variables.

Employing the IV probit model, the results of the first step are shown in Table 2. It demonstrates how formal care cost and informal care cost interacts with the instrumental variables. The sample size in this model analysis was 4546.

The instrumental variable, the access to hospitals, is efficient in explaining formal care cost, and a negative relationship was found between them. The access to hospitals did not affect informal care cost, but the number of household members, had a significant positive effect on it. The Wald test of exogeneity gave a chi square of 1.24, with a p-value of 0.5392. The exogeneity that the care cost variables had with the receipt of disability benefits cannot be rejected. Instead of using the IV probit model, this paper used probit model analysis. But the fact that we have managed to test the endogeneity with valid instrumental variables is a step forward.

## 5.5 Results

### 5.5.1 Probit model with the whole sample

Table 5.3: Results of probit model on whole sample

| RDB | Mar.Eff. | Std. Err. | z | $P > z$ | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| lnTI | -0.013 | 0.006 | -2.410 | 0.016 | -0.024 | -0.002 |
| lnNTW | -0.009 | 0.002 | -5.940 | 0.000 | -0.012 | -0.006 |
| ADL | 0.015 | 0.002 | 6.750 | 0.000 | 0.011 | 0.019 |
| SRH1 | 0.104 | 0.022 | 4.760 | 0.000 | 0.061 | 0.147 |
| SRH2 | 0.078 | 0.020 | 3.880 | 0.000 | 0.039 | 0.117 |
| SRH3 | 0.026 | 0.020 | 1.320 | 0.187 | -0.013 | 0.066 |
| SRH4 | -0.003 | 0.021 | -0.160 | 0.873 | -0.045 | 0.038 |
| lnTFCC | 0.010 | 0.003 | 3.090 | 0.002 | 0.004 | 0.016 |
| lnTIFCC | 0.017 | 0.002 | 8.100 | 0.000 | 0.013 | 0.021 |
| Age | 0.001 | 0.001 | 0.980 | 0.329 | -0.001 | 0.002 |
| Gender | -0.019 | 0.009 | -2.130 | 0.033 | -0.036 | -0.002 |
| MS | 0.015 | 0.009 | 1.750 | 0.081 | -0.002 | 0.033 |
| Hobby | 0.004 | 0.008 | 0.500 | 0.620 | -0.012 | 0.021 |
| Insurance | -0.025 | 0.013 | -1.880 | 0.061 | -0.052 | 0.001 |

Table 3 presents results from the carry-out of the first probit model with marginal effects reported, which is run to the complete set of the sample. Any missing value made that observation excluded from this test by default. The sample size of this model analysis was 4,683. The results that report coefficients can be found in Appendix 4.

The wealth and income variables are significant in deciding on the receipt of disability benefits. Both variables related negatively with the receipt of disability benefits. Thus the trend exists that the more income or wealth one has, the less likely the individual is to receive any disability benefit, given that other variables are held constant. LnTI had a marginal effect of $-0.013$, so for each percent of increase of total income, the chance of the participant receiving disability benefits decreased by 1.3%. With the variable of net total wealth, the marginal effect being -0.009 shows that increasing one percent in net total asset made the possibility of receiving disability benefits decrease by 0.9%.

The factors of formal care cost and informal care cost both generated significant positive coefficients, which suggest that people with higher informal care cost or formal care cost are more likely to have disability benefits when other variables are kept unchanged. The marginal effects of log of formal care cost and informal care cost were 0.010 and 0.017. This means that given per unit change of the independent variables, the possibility for the receipt of disability benefits happening moved 1 % and 1.7 % in the same direction. The scope of change of possibility due to informal care cost was bigger than that of the formal care cost.

The ADL score shows a positive relationship with the receipt of disability benefits. The higher the ADL score was, the more limiting the participant's daily life was, the higher the possibility was to receive the benefits. For each other activity that the participants could not manage to finish, the chance of the participants receiving disability benefits increased by 1.5%. The first two levels of self-rated health, which are poor and fair, were significant in affecting the possibility of the dependent variable happening. The change from the excellent health level to poor health level increased the chance of a person receiving disability benefits by 10.4%. If the health level changed from excellent to fair instead, the possibility of receiving disability benefits increased by 7.8%.

In the model, the results of socio-demographic factors were found not quite as expected. The variable of age was not a significant variable, which means participants' age did not affect the decisions of giving out disability benefits. Gender was significant in deciding the receipt of disability benefits. But unlike the initial data analysis, the results show that men are more likely to receive disability benefits than women. This is because using the whole set of variables decreased the sample size and changed the proportions of men and women. The marital status, whether for purchases of insurance and whether a person has a hobby or pastime was not significant in the model.

The targeting of the disability benefits are for the people who are in need of long-term care regardless of the financial status. People in poorer health are much more likely to receive disability benefits, but the connections between income and wealth and the receipt of disability benefit are still evident. To better understand how strong their connections are, sensitivity and robustness tests were necessary for both variables.

### 5.5.2 Robustness Tests for Income and Wealth Variables

Table 5.4: Results of probit model on 1st income group

| RDB | Mar.Eff. | Std. Err. | z | $P > z$ | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| lnTI | 0.014 | 0.014 | 1.040 | 0.296 | -0.012 | 0.041 |
| lnNTW | -0.012 | 0.003 | -3.460 | 0.001 | -0.018 | -0.005 |
| ADL | 0.017 | 0.005 | 3.660 | 0.000 | 0.008 | 0.027 |
| SRH1 | 0.161 | 0.061 | 2.660 | 0.008 | 0.042 | 0.280 |
| SRH2 | 0.123 | 0.057 | 2.150 | 0.032 | 0.011 | 0.236 |
| SRH3 | 0.059 | 0.058 | 1.030 | 0.305 | -0.054 | 0.173 |
| SRH4 | 0.045 | 0.060 | 0.750 | 0.455 | -0.073 | 0.163 |
| lnTFCC | 0.009 | 0.008 | 1.140 | 0.253 | -0.006 | 0.025 |
| lnTIFCC | 0.025 | 0.004 | 5.780 | 0.000 | 0.017 | 0.034 |
| Age | 0.001 | 0.001 | 0.910 | 0.363 | -0.001 | 0.004 |
| Gender | -0.048 | 0.024 | -2.000 | 0.045 | -0.095 | -0.001 |
| MS | 0.035 | 0.022 | 1.620 | 0.106 | -0.007 | 0.077 |
| Hobby | -0.028 | 0.020 | -1.390 | 0.165 | -0.068 | 0.012 |
| Insurance | -0.009 | 0.037 | -0.250 | 0.805 | -0.081 | 0.063 |

Table 5.5: Results of probit model on 2nd income group

| RDB | Mar.Eff. | Std. Err. | z | $P > z$ | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| lnTI | 0.103 | 0.068 | 1.500 | 0.133 | -0.031 | 0.236 |
| lnNTW | -0.011 | 0.003 | -3.670 | 0.000 | -0.017 | -0.005 |
| ADL | 0.022 | 0.005 | 4.540 | 0.000 | 0.013 | 0.032 |
| SRH1 | 0.202 | 0.071 | 2.850 | 0.004 | 0.063 | 0.341 |
| SRH2 | 0.157 | 0.069 | 2.280 | 0.022 | 0.022 | 0.291 |
| SRH3 | 0.094 | 0.069 | 1.370 | 0.169 | -0.040 | 0.229 |
| SRH4 | 0.070 | 0.070 | 0.990 | 0.320 | -0.068 | 0.207 |
| lnTFCC | 0.012 | 0.008 | 1.510 | 0.130 | -0.003 | 0.027 |
| lnTIFCC | 0.018 | 0.005 | 3.740 | 0.000 | 0.009 | 0.027 |
| Age | -0.001 | 0.001 | -0.960 | 0.335 | -0.004 | 0.001 |
| Gender | -0.036 | 0.020 | -1.840 | 0.066 | -0.075 | 0.002 |
| MS | 0.047 | 0.021 | 2.240 | 0.025 | 0.006 | 0.087 |
| Hobby | 0.007 | 0.019 | 0.380 | 0.701 | -0.030 | 0.044 |
| Insurance | -0.087 | 0.035 | -2.470 | 0.014 | -0.155 | -0.018 |

Table 5.6: Results of probit model on 3rd income group

| RDB | Mar.Eff. | Std. Err. | z | $P > z$ | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| lnTI | -0.008 | 0.058 | -0.140 | 0.885 | -0.122 | 0.105 |
| lnNTW | -0.007 | 0.004 | -1.550 | 0.121 | -0.015 | 0.002 |
| ADL | 0.017 | 0.005 | 3.560 | 0.000 | 0.008 | 0.026 |
| SRH1 | 0.053 | 0.036 | 1.450 | 0.147 | -0.019 | 0.124 |
| SRH2 | 0.027 | 0.032 | 0.840 | 0.402 | -0.036 | 0.089 |
| SRH3 | -0.024 | 0.032 | -0.760 | 0.449 | -0.086 | 0.038 |
| SRH4 | -0.067 | 0.036 | -1.840 | 0.065 | -0.138 | 0.004 |
| lnTFCC | 0.008 | 0.007 | 1.250 | 0.211 | -0.005 | 0.021 |
| lnTIFCC | 0.014 | 0.004 | 3.400 | 0.001 | 0.006 | 0.023 |
| Age | 0.001 | 0.001 | 0.700 | 0.483 | -0.002 | 0.003 |
| Gender | -0.010 | 0.017 | -0.580 | 0.562 | -0.043 | 0.023 |
| MS | -0.013 | 0.018 | -0.710 | 0.478 | -0.048 | 0.022 |
| Hobby | 0.038 | 0.017 | 2.270 | 0.023 | 0.005 | 0.070 |
| Insurance | -0.009 | 0.031 | -0.300 | 0.766 | -0.069 | 0.051 |

Table 5.7: Results of probit model on 4th income group

| RDB | Mar.Eff. | Std. Err. | z | $P > z$ | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| lnTI | -0.034 | 0.019 | -1.800 | 0.072 | -0.072 | 0.003 |
| lnNTW | -0.003 | 0.005 | -0.670 | 0.502 | -0.013 | 0.006 |
| ADL | 0.002 | 0.003 | 0.750 | 0.454 | -0.004 | 0.009 |
| SRH1 | 0.048 | 0.032 | 1.480 | 0.139 | -0.015 | 0.111 |
| SRH2 | 0.059 | 0.027 | 2.140 | 0.033 | 0.005 | 0.113 |
| SRH3 | 0.032 | 0.027 | 1.190 | 0.234 | -0.021 | 0.084 |
| SRH4 | 0.010 | 0.028 | 0.350 | 0.729 | -0.045 | 0.064 |
| lnTFCC | 0.013 | 0.004 | 3.190 | 0.001 | 0.005 | 0.021 |
| lnTIFCC | 0.011 | 0.003 | 3.620 | 0.000 | 0.005 | 0.018 |
| Age | 0.001 | 0.001 | 0.990 | 0.323 | -0.001 | 0.002 |
| Gender | 0.001 | 0.012 | 0.080 | 0.937 | -0.023 | 0.025 |
| MS | -0.009 | 0.012 | -0.710 | 0.477 | -0.033 | 0.016 |
| Hobby | -0.011 | 0.013 | -0.810 | 0.419 | -0.037 | 0.016 |
| Insurance | -0.018 | 0.013 | -1.410 | 0.158 | -0.044 | 0.007 |

To conduct the robustness tests, income and wealth variables were divided into four equal-shared groups, and probit models were carried out within these income and wealth groups separately. The purpose was to examine how the receipt of disability benefits is related to income and wealth factors when the participants are set in different range and financial positions. The results can show us which groups of the society are targeted and well covered by the current disability social benefits, and it can help the government understand better about the structure of the recipients and the performance of the current services.

Participants were divided into four equal groups by the income variable first. The dividing points of their incomes were £139.78, £217.82 and £349.72. The sample sizes of the four probit models on these four groups were 1069, 1127, 1213 and 1275. The differences in sample size were due to the omissions of participants who had missing data after adding other variables.

The results are shown in Tables 5.4-5.7. Under such conditions, the variable of income did not show significant relationships with the receipt of disability benefits in all four groups. So when the variance of income was lower, income differences did not account significantly regarding the chance of receiving disability benefits. But the variable of net total wealth showed significant negative coefficients in the first two groups. The marginal effects of them were $-0.012$ and $-0.011$. The chance of becoming recipients of disability benefit grew by $1.2\%$ and $1.1\%$ separately when net total wealth rose $1\%$ within income group 1 and 2. This was higher than the marginal effect in the probit model of the complete sample. In lower income groups, the connections between wealth differences and the receipt of disability benefits was stronger.

In the first and second income group, total ADL score and poor and fair health level were also proven to have effects on the dependent variable. The strong relationships between the health factors were more reflected in the lower income groups as only one of these three variables was significant in the last two income groups. Total formal care cost was only significant in the fourth income group, and informal care cost was significant in all four groups. This reflects the facts that the recipients of formal care cost were more likely to have high income, and most care receivers relied on informal care.

Table 5.8: Results of probit model on 1st wealth group

| RDB | Mar.Eff. | Std. Err. | z | $P > z$ | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| lnTI | 0.000 | 0.017 | 0.020 | 0.980 | -0.033 | 0.034 |
| lnNTW1 | -0.010 | 0.004 | -2.600 | 0.009 | -0.018 | -0.002 |
| ADL | 0.021 | 0.006 | 3.320 | 0.001 | 0.009 | 0.033 |
| SRH1 | 0.168 | 0.076 | 2.210 | 0.027 | 0.019 | 0.317 |
| SRH2 | 0.118 | 0.072 | 1.630 | 0.102 | -0.024 | 0.260 |
| SRH3 | 0.037 | 0.073 | 0.500 | 0.614 | -0.106 | 0.180 |
| SRH4 | -0.007 | 0.077 | -0.090 | 0.926 | -0.159 | 0.144 |
| lnTFCC | 0.026 | 0.009 | 2.790 | 0.005 | 0.008 | 0.044 |
| lnTIFCC | 0.028 | 0.005 | 5.180 | 0.000 | 0.018 | 0.039 |
| Age | -0.002 | 0.002 | -1.410 | 0.159 | -0.006 | 0.001 |
| Gender | -0.006 | 0.026 | -0.240 | 0.809 | -0.057 | 0.045 |
| MS | 0.035 | 0.025 | 1.380 | 0.169 | -0.015 | 0.085 |
| Hobby | -0.043 | 0.024 | -1.780 | 0.075 | -0.091 | 0.004 |
| Insurance | -0.154 | 0.064 | -2.390 | 0.017 | -0.280 | -0.028 |

Table 5.9: Results of probit model on 2nd wealth group

| RDB | Mar.Eff. | Std. Err. | z | $P > z$ | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| lnTI | -0.010 | 0.011 | -0.860 | 0.390 | -0.032 | 0.012 |
| lnNTW2 | -0.063 | 0.046 | -1.360 | 0.174 | -0.154 | 0.028 |
| ADL | 0.019 | 0.005 | 4.080 | 0.000 | 0.010 | 0.028 |
| SRH1 | 0.050 | 0.042 | 1.190 | 0.233 | -0.032 | 0.132 |
| SRH2 | 0.021 | 0.037 | 0.550 | 0.582 | -0.053 | 0.094 |
| SRH3 | -0.022 | 0.037 | -0.590 | 0.558 | -0.095 | 0.051 |
| SRH4 | -0.071 | 0.041 | -1.710 | 0.087 | -0.151 | 0.010 |
| lnTFCC | -0.003 | 0.008 | -0.350 | 0.724 | -0.018 | 0.013 |
| lnTIFCC | 0.018 | 0.004 | 4.220 | 0.000 | 0.010 | 0.027 |
| Age | 0.001 | 0.001 | 0.830 | 0.405 | -0.001 | 0.004 |
| Gender | -0.036 | 0.019 | -1.910 | 0.056 | -0.072 | 0.001 |
| MS | 0.023 | 0.019 | 1.230 | 0.218 | -0.014 | 0.061 |
| Hobby | 0.013 | 0.017 | 0.750 | 0.454 | -0.021 | 0.047 |
| Insurance | -0.030 | 0.028 | -1.070 | 0.286 | -0.085 | 0.025 |

Table 5.10: Results of probit model on 3rd wealth group

| RDB | Mar.Eff. | Std. Err. | z | $P > z$ | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| lnTI | -0.013 | 0.011 | -1.130 | 0.259 | -0.035 | 0.009 |
| lnNTW3 | -0.075 | 0.042 | -1.760 | 0.078 | -0.158 | 0.008 |
| ADL | 0.015 | 0.004 | 4.080 | 0.000 | 0.008 | 0.023 |
| SRH1 | 0.108 | 0.043 | 2.520 | 0.012 | 0.024 | 0.193 |
| SRH2 | 0.088 | 0.040 | 2.180 | 0.029 | 0.009 | 0.167 |
| SRH3 | 0.047 | 0.040 | 1.180 | 0.240 | -0.031 | 0.124 |
| SRH4 | 0.025 | 0.041 | 0.620 | 0.535 | -0.055 | 0.106 |
| lnTFCC | 0.004 | 0.005 | 0.820 | 0.415 | -0.006 | 0.015 |
| lnTIFCC | 0.009 | 0.004 | 2.530 | 0.011 | 0.002 | 0.017 |
| Age | 0.002 | 0.001 | 2.480 | 0.013 | 0.001 | 0.004 |
| Gender | -0.019 | 0.015 | -1.260 | 0.208 | -0.049 | 0.011 |
| MS | 0.000 | 0.015 | -0.030 | 0.980 | -0.030 | 0.030 |
| Hobby | 0.030 | 0.014 | 2.110 | 0.035 | 0.002 | 0.058 |
| Insurance | 0.010 | 0.026 | 0.390 | 0.696 | -0.040 | 0.060 |

Table 5.11: Results of probit model on 4th wealth group

| RDB | Mar.Eff. | Std. Err. | z | $P > z$ | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| lnTI | -0.012 | 0.008 | -1.530 | 0.126 | -0.026 | 0.003 |
| lnNTW4 | 0.006 | 0.011 | 0.560 | 0.574 | -0.016 | 0.028 |
| ADL | 0.006 | 0.003 | 2.250 | 0.025 | 0.001 | 0.012 |
| SRH1 | 0.056 | 0.028 | 2.000 | 0.045 | 0.001 | 0.112 |
| SRH2 | 0.051 | 0.024 | 2.130 | 0.033 | 0.004 | 0.099 |
| SRH3 | 0.015 | 0.024 | 0.620 | 0.533 | -0.032 | 0.062 |
| SRH4 | 0.018 | 0.024 | 0.730 | 0.464 | -0.030 | 0.065 |
| lnTFCC | 0.013 | 0.004 | 3.180 | 0.001 | 0.005 | 0.021 |
| lnTIFCC | 0.011 | 0.003 | 3.750 | 0.000 | 0.005 | 0.017 |
| Age | -0.001 | 0.001 | -0.720 | 0.469 | -0.002 | 0.001 |
| Gender | 0.005 | 0.011 | 0.410 | 0.684 | -0.018 | 0.027 |
| MS | 0.009 | 0.011 | 0.800 | 0.423 | -0.013 | 0.031 |
| Hobby | 0.011 | 0.011 | 0.940 | 0.348 | -0.012 | 0.033 |
| Insurance | -0.021 | 0.012 | -1.830 | 0.067 | -0.044 | 0.001 |

Tables 5.8-5.11 show the results of the probit model in the four wealth groups. The dividing points of the wealth groups were £95,340, £175,267 and £306,667. The sample sizes were $1,015$, $1,206$, $1,241$, $1,222$. The variable of net total wealth shows a significant negative relationship with the receipt of disability benefits in the first wealth group. This suggests that in the group where people had less wealth, the wealthier one was the less chance was to receive disability benefits. The marginal effect was $0.010$, which was slightly higher than that in the complete sample. But in the other three wealth groups, net

total wealth was not significant. But it is observable that the variance of net total wealth was huge and the scale of wealth became very big even after second group. The effects from the income factor on the dependent variable could not be found in all the wealth groups.

The connections of health factors and the receipt of disability benefits were more consistent across the wealth groups than the income groups. But the marginal effects in the lower wealth groups were more than in the higher wealth groups and much higher than in the complete sample, especially the poor self-rated health in the first wealth group. Compared to the excellent health level, a poor health observant had a $16.8\%$ greater chance to receive disability benefits.

The effects that income and wealth factors had on the receipt of disability benefits were not consistently significant when individuals were put into groups with similar finance status. But the negative relationship that net total wealth had with the dependent variable could be found in the lowest income group and the first two wealth groups. However, income factor did not significantly affect the receipt of disability benefits in any group. To examine their relationships further, the next step was to set the variables of income and wealth into ten dummy variables representing ten different income and wealth levels from low to high. By dividing the income and wealth more specifically, we could analyze how the wealth and income level affected the dependent variable when comparisons were made among refinery levels.

Table 5.12 shows the results of the probit model on income and wealth dummy variables. The variable of total income shows consistently a significant positive coefficient and marginal effects with all nine dummy variables. This indicates the fact that compared to the highest income level, people at lower income level were more likely to receive disability benefits. Meanwhile the marginal effects were generally higher in the first five dummy variables than in the later ones. This showed that the lower the income level an individual was on, the greater the chance they had of receiving disability benefit. For

Table 5.12: Results of probit model on income and wealth dummies

| RBD | Mar.Eff. | Std. Err. | z | P¿z | 95% Conf. Interval | |
|---|---|---|---|---|---|---|
| TI1 | 0.081 | 0.027 | 2.990 | 0.003 | 0.028 | 0.133 |
| TI2 | 0.108 | 0.026 | 4.160 | 0.000 | 0.057 | 0.159 |
| TI3 | 0.072 | 0.026 | 2.750 | 0.006 | 0.021 | 0.124 |
| TI4 | 0.094 | 0.026 | 3.670 | 0.000 | 0.044 | 0.145 |
| TI5 | 0.106 | 0.025 | 4.160 | 0.000 | 0.056 | 0.155 |
| TI6 | 0.077 | 0.026 | 3.010 | 0.003 | 0.027 | 0.127 |
| TI7 | 0.087 | 0.026 | 3.370 | 0.001 | 0.036 | 0.137 |
| TI8 | 0.065 | 0.026 | 2.480 | 0.013 | 0.014 | 0.116 |
| TI9 | 0.079 | 0.026 | 3.080 | 0.002 | 0.029 | 0.129 |
| NTW1 | 0.071 | 0.020 | 3.570 | 0.000 | 0.032 | 0.110 |
| NTW2 | 0.028 | 0.020 | 1.380 | 0.169 | -0.012 | 0.067 |
| NTW3 | 0.032 | 0.020 | 1.580 | 0.114 | -0.008 | 0.071 |
| NTW4 | 0.025 | 0.020 | 1.220 | 0.223 | -0.015 | 0.064 |
| NTW5 | -0.001 | 0.021 | -0.050 | 0.963 | -0.041 | 0.039 |
| NTW6 | 0.020 | 0.020 | 1.020 | 0.309 | -0.019 | 0.060 |
| NTW7 | 0.007 | 0.021 | 0.320 | 0.753 | -0.034 | 0.048 |
| NTW8 | -0.037 | 0.023 | -1.600 | 0.109 | -0.082 | 0.008 |
| NTW9 | -0.029 | 0.023 | -1.240 | 0.215 | -0.074 | 0.017 |
| ADL | 0.015 | 0.002 | 6.670 | 0.000 | 0.010 | 0.019 |
| SRH1 | 0.104 | 0.022 | 4.740 | 0.000 | 0.061 | 0.148 |
| SRH2 | 0.074 | 0.020 | 3.640 | 0.000 | 0.034 | 0.114 |
| SRH3 | 0.022 | 0.020 | 1.110 | 0.269 | -0.017 | 0.062 |
| SRH4 | -0.006 | 0.021 | -0.260 | 0.792 | -0.048 | 0.036 |
| lnTFCC | 0.011 | 0.003 | 3.230 | 0.001 | 0.004 | 0.017 |
| lnTIFCC | 0.017 | 0.002 | 8.270 | 0.000 | 0.013 | 0.021 |
| Age | 0.000 | 0.001 | 0.820 | 0.411 | -0.001 | 0.002 |
| Gender | -0.019 | 0.009 | -2.100 | 0.036 | -0.036 | -0.001 |
| MS | 0.012 | 0.009 | 1.330 | 0.184 | -0.006 | 0.030 |
| Hobby | 0.003 | 0.008 | 0.360 | 0.720 | -0.013 | 0.020 |
| Insurance | -0.034 | 0.014 | -2.400 | 0.017 | -0.061 | -0.006 |

example, if one's income level has dropped from the 10th group to the 2nd group, the possibility for this participant to receive disability benefit increases $10.8\%$. But changing from the 10th group to 8th group only increases the possibility by $6.5\%$.

But when comparing wealth groups, only the first dummy variable showed a significant result. This suggests that except for the comparisons made between individuals who held the most and less wealth, the differences in other wealth levels did not affect the receipt of disability benefits. The marginal effect of the first dummy was $0.071$ suggesting that the change from the 10th group to the 1st increases the possibility to receive disability benefits by $7.1\%$.

Testing the ten dummies of income and wealth variables, income factor showed a stronger and more consistent negative relationship with the receipt of disability benefits, while the wealth factor was only significant when the highest and lowest level was compared. This can be due to the fact that income dominates individuals' daily consumptions, which is more connected to one's life standard. Although wealth comes in larger amounts, it is less flexible to use.

## 5.6 Discussion

Testing the outcomes of the disability benefits, individuals with better financial status were less likely to receive disability benefits. Although Attendance Allowance and Disability Living Allowance aim to provide benefits to those who have care needs and are over 65, regardless of the claimants' income or wealth level, the results show that the access to these benefits has significant connections with a person's income and wealth level, which are similar effects to means-tested policies. There exists a self-selection process as opportunity cost can be generated during the claiming. When the opportunity cost of the claim is larger than the benefits that could be gained, individuals choose not to claim. Richer people have a higher opportunity cost to claim, so the initiatives for the richer people to claim are lower. On the other hand, the chance of having more severe disability is higher among the poorer people, and their opportunity to receive disability benefits is higher. Also, the artificial factors cannot be neglected. The process of the decision-making for a claim is entirely controlled by assessors. With the complex disability status being very hard to transform into very accurate and detailed guidelines, sometimes the subjective criteria can make decisions very different even on similar cases.

In the robustness tests where four equalized groups of different income or wealth level were formed, the factor of income did not show a distinctive relationship with the receipt of disability benefits in any group. In groups where the sample size was reduced and the variances of wealth and income were much smaller, income factor did not affect the chance of getting disability benefits. However, in the lower income groups, met total wealth was an essential parameter influencing the outcomes of receiving disability benefits. Wealth represents households' assets, and has more dramatic changes in scale than income. Compared to income, a much lower wealth level can reflect better of a person's limited financial resource. When we targeted lower income groups, the wealth differences became striking. In the four wealth groups, only the group with the lowest wealth range, showed the significance of net total wealth. Thus, when people from similar income or wealth level were observed, the self-selection process based on income level was not very distinctive, but participants' wealth became an important role in the underlying means test process.

After investigating the income and wealth as ten divided levels, compared with highest level, all the participants of other income levels had significantly higher chances to receive disability benefits. Only the lowest wealth level had an increasing possibility to become benefit recipients when compared to those in the highest wealth level. Compared the same income level, the targeting of the disability benefits is the people of lower wealth levels. But when it was in a wider range of income, the significance of the relationships between income and the receipt of disability benefits was more consistent. It is fair to say that the level of income starting self-selecting was quite high and covered most of the participants.

Compared to local LTC services, the coverage of disability cash benefits was less limiting. It is necessary to keep and strengthen the disability cash benefits for elderly people, rather than just diverting them to expand the public private care services of local authorities.

## 5.7 Conclusions

This paper has looked into the issue of the elderly's long-term care (LTC) benefit policies in England, focusing on the disability benefit targeting and effectiveness. By applying the method of the probit model and relevant robustness tests to 5685 observations from the English Longitudinal Study of Ageing (ELSA) of people who were 65 and over, this paper has analyzed mainly the roles of income and wealth in affecting the chances of individuals receiving the non means-tested disability benefits. This can help the policy makers to understand better the financial structures of the recipients and how the LTC disability benefits are carried out in real life. During the analysis, instrumental variables of care cost were found and its endogeneity problem with the receipt of disability benefits was studied by using the IV probit approach.

The results of the IV probit show that the access to hospital and the number of members in a household can be used as valid instrumental variables for the endogenous variables of total formal care cost and total informal care cost. Although the causations between care cost and the receipt of disability benefits are believed to flow in both directions, the endogeneity between them was not detected. It was therefore safe to use the probit model to evaluate the data.

The probit model was used to test under what circumstances of the independent variables the dependant variable - the receipt of disability benefits was more likely to happen. The results show that individuals with higher income or wealth were less likely to receive disability benefits, regardless of the non means-tested design. The disability cash benefits performed similarly with the means-tested policy due to a self-selection process. Robustness tests showed that in smaller groups where the level of income or wealth was similar and the variances were small, the income factor did not have effects on the results of whether participants became recipients of the benefits, but the wealth factor was shown to be significant in the lower income or wealth groups. When compared to a higher level of income, the income variable showed a consistent significant negative effect on the receipt of disability benefit. The wealth factor also showed a significant relationship with the dependent variable when the lowest was compared with the highest wealth level. Overall, the disability benefits of AA and DLA are provided to those who are most in need of care and in the worst financial positions.

Income is a factor that shows more of the individuals' lifestyle and ability of consumption, and wealth is a more significant variable in assessing the financial differences, and can be more efficient in distinguishing the people who are in the worst financial conditions. Both of them are important assessments in giving out benefits. Some policies consider the effects from income or wealth in the criteria, but even for those which do not mention financial status in their criteria, both factors still have a profound influence on the carry-out and outcomes of the policies. When the government chooses to focus on either the state cash benefits, or the personal care provided from the local authorities, it is necessary to understand that individuals' financial status has already been taken into consideration.

This paper has focused on testing income and wealth factors, so did not analyse other controlled variables more specifically. The results section shows a different result on gender divide from the preliminary analysis. The dropping of the lifestyle factors of the hobby and insurance variable result to the insignificance of the gender variable Appendix 5. The gender divide problem is not found in this case. Another limitation was that the data was collected from England, and this paper analysed the problem treating England as a whole. The geographic differences that are within England was not taken into consideration. The average income and wealth level of individuals have great differences when comparing those from the London area and other places. If the data of more specific areas can be acquired, further research can take into consideration different areas to analyse the problems of income divide.

## 5.8 Appendices

### 5.8.1 Appendix 1 Variables Definitions and Statistics Summary

Table A1: Variables definitions and statistics summary

| Var | Definition | Obs | Mean | Std.Dev. |
|---|---|---|---|---|
| **Dependent variable** | | | | |
| RDB | The receipt of disability benefits Receiving either AA or DLA (1) Neither receiving AA or DLA (0) | 5,595 | 8.43 | 25.92 |
| **Income and Wealth variables** | | | | |
| TI | Total Income | 5,555 | 292.59 | 415.28 |
| NTW | Net Total Wealth | 5,555 | 258,081.30 | 419.100.50 |
| **Health Variables** | | | | |
| SRH1 | Self-rated Health - Poor | 5350 | 0.09 | 0.29 |
| SRH2 | Self-rated Health - Fair | 5350 | 0.23 | 0.42 |
| SRH3 | Self-rated Health - Good | 5350 | 0.33 | 0.47 |
| SRH4 | Self-rated Health - Very good | 5350 | 0.27 | 0.44 |
| SRH5 | Self-rated Health - Excellent | 5350 | 0.08 | 0.28 |
| ADL | Number of Activities of Daily living | 5681 | 1.19 | 2.55 |
| TIFCC | Total Informal Care Cost | 5685 | 50.02 | 205.67 |
| TFCC | Total Formal Care Cost | 5685 | 10.38 | 79.83 |
| **Socio-Demographic Variables** | | | | |
| Age | Age | 5685 | 74.10 | 7.00 |
| Gender | Female (1) or Male (0) | 5685 | 0.54 | 0.50 |
| MS | Marital Status: A civil partner, married orre-married(0); Single, divorced or widowed (1) | 5685 | 0.36 | 0.48 |
| Insurance | Whether purchased private health insurance: Purchased (0); Not purchased (1) | 5677 | 0.91 | 0.29 |
| Hobby | Whether have a hobby or pas-time Have (0); Do not have(1) | 4834 | 0.23 | 0.42 |
| **Instrumental Variables** | | | | |
| Ho1 | Access to Hospitals-Very easy | 4699 | 0.37 | 0.48 |
| Ho2 | Access to Hospitals-Quite easy | 4699 | 0.45 | 0.50 |
| Ho3 | Access to Hospitals-Quite difficult | 4699 | 0.12 | 0.33 |
| Ho4 | Access to Hospitals-Very difficult | 4699 | 0.04 | 0.20 |
| Ho5 | Access to Hospitals-Unable to go | 4699 | 0.01 | 0.08 |
| NOH | Number of Household Members | 5685 | 1.78 | 0.69 |

### 5.8.2 Appendix 2 Histograms of Variables

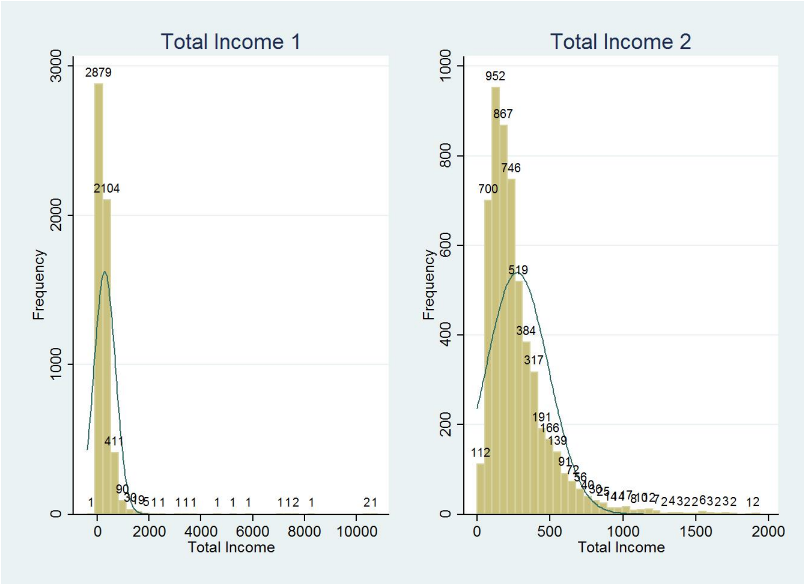


Figure A1: Histograms of total income

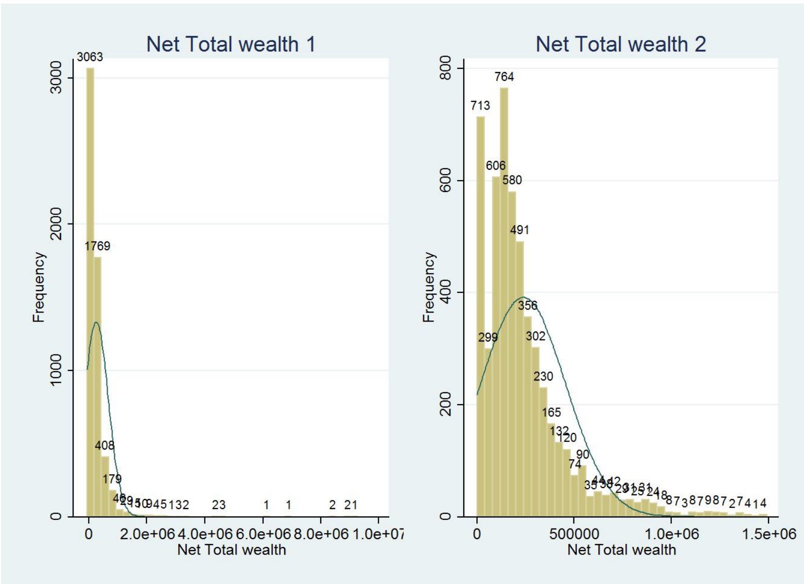


Figure A2: Histograms of net total wealth

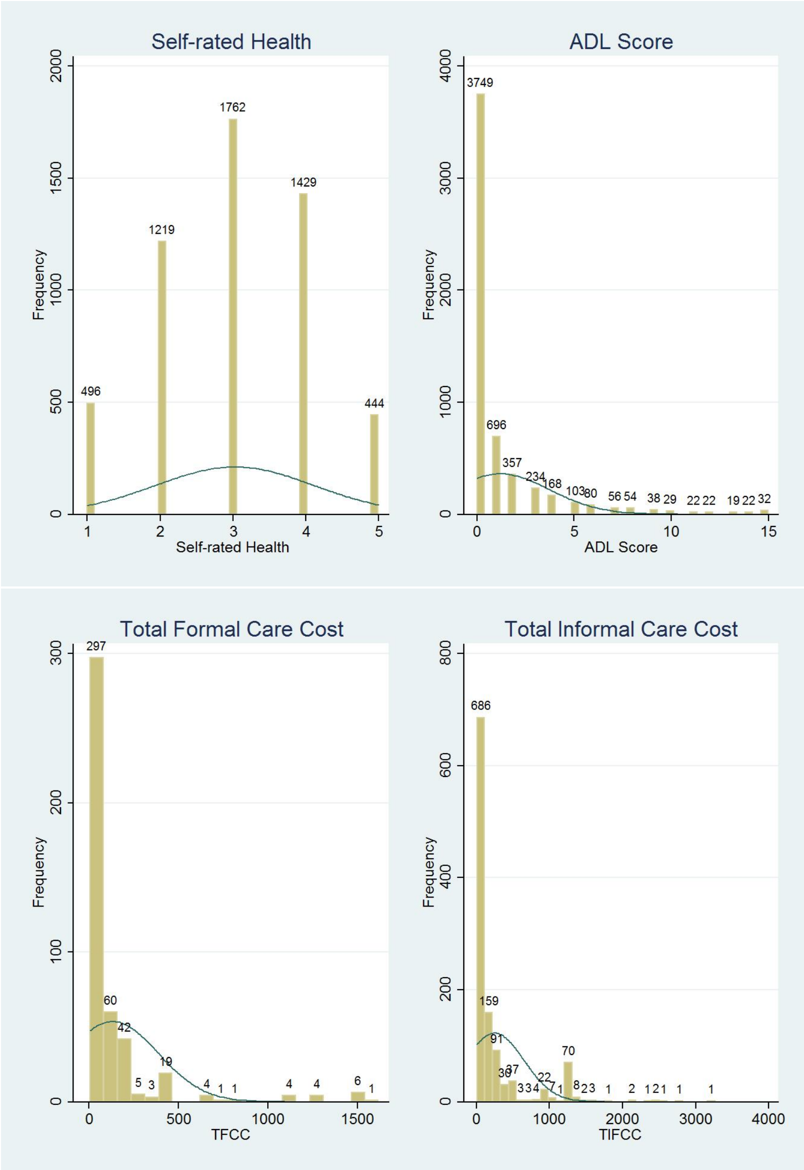


Figure A3: Histograms of health variables

Table A2: Correlation coefficients of all variables

| | RDB | TI | NTW | SRH1 | SRH2 | SRH3 | SRH4 | SRH5 | ADL | TIFCC | TFCC | Age | Gender | MS | Insuance | Hobby |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RDB | 1 | | | | | | | | | | | | | | | |
| TI | -0.0653 | 1 | | | | | | | | | | | | | | |
| NTW | -0.092 | 0.5328 | 1 | | | | | | | | | | | | | |
| SRH1 | 0.2879 | -0.0605 | -0.0899 | 1 | | | | | | | | | | | | |
| SRH2 | 0.1179 | -0.0724 | -0.0959 | -0.1602 | 1 | | | | | | | | | | | |
| SRH3 | -0.0933 | -0.0043 | 0.0116 | -0.2114 | -0.3787 | 1 | | | | | | | | | | |
| SRH4 | -0.1397 | 0.0699 | 0.0822 | -0.184 | -0.3296 | -0.435 | 1 | | | | | | | | | |
| SRH5 | -0.0772 | 0.0622 | 0.0796 | -0.0923 | -0.1654 | -0.2184 | -0.1901 | 1 | | | | | | | | |
| ADL | 0.4042 | -0.0819 | -0.1082 | 0.4295 | 0.1682 | -0.1107 | -0.2194 | -0.1339 | 1 | | | | | | | |
| TIFCC | 0.2929 | -0.051 | -0.0681 | 0.2607 | 0.0818 | -0.0843 | -0.1094 | -0.0603 | 0.4749 | 1 | | | | | | |
| TFCC | 0.1365 | -0.0118 | -0.0138 | 0.0734 | 0.045 | -0.0181 | -0.0499 | -0.0288 | 0.3001 | 0.0681 | 1 | | | | | |
| Age | 0.1067 | -0.0914 | -0.0778 | 0.0694 | 0.0718 | 0.0048 | -0.0659 | -0.0772 | 0.2214 | 0.1244 | 0.1173 | 1 | | | | |
| Gender | 0.0085 | -0.2056 | -0.0458 | -0.0151 | 0.0074 | 0.0005 | -0.0039 | 0.0092 | 0.0506 | 0.0418 | 0.0461 | 0.0314 | 1 | | | |
| MS | 0.0778 | -0.0578 | -0.0784 | 0.0605 | 0.0785 | -0.023 | -0.0648 | -0.0337 | 0.1173 | -0.0019 | 0.1045 | 0.2679 | 0.2418 | 1 | | |
| Insurance | 0.1251 | -0.0757 | -0.0941 | 0.1758 | 0.0989 | -0.0289 | -0.1125 | -0.0908 | 0.2108 | 0.1346 | 0.0644 | 0.154 | 0.0074 | 0.1194 | 1 | |
| Hobby | 0.0376 | -0.1617 | -0.1951 | 0.0604 | 0.057 | -0.0199 | -0.0361 | -0.0525 | 0.0571 | 0.0422 | 0.0065 | 0.0423 | 0.0127 | 0.0475 | 0.059 | 1 |

### 5.8.3 Appendix 3 Correlation Coefficients

### 5.8.4 Appendix 4 Probit Models with Coefficients Reported

Table A3: Results of probit model on whole sample (Coef.)

| RDB | Coef. | Std. Err. | z | $P > z$ | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| lnTI | -0.103 | 0.043 | -2.410 | 0.016 | -0.187 | -0.019 |
| lnNTW | -0.072 | 0.012 | -5.910 | 0.000 | -0.096 | -0.048 |
| ADL | 0.115 | 0.017 | 6.680 | 0.000 | 0.081 | 0.149 |
| SRH1 | 0.807 | 0.169 | 4.770 | 0.000 | 0.475 | 1.138 |
| SRH2 | 0.602 | 0.155 | 3.890 | 0.000 | 0.299 | 0.906 |
| SRH3 | 0.204 | 0.154 | 1.320 | 0.186 | -0.099 | 0.507 |
| SRH4 | -0.026 | 0.163 | -0.160 | 0.873 | -0.346 | 0.294 |
| lnTFCC | 0.078 | 0.025 | 3.080 | 0.002 | 0.028 | 0.127 |
| lnTIFCC | 0.129 | 0.016 | 8.060 | 0.000 | 0.097 | 0.160 |
| Age | 0.004 | 0.005 | 0.980 | 0.329 | -0.004 | 0.013 |
| Gender | -0.144 | 0.067 | -2.140 | 0.033 | -0.276 | -0.012 |
| MS | 0.118 | 0.068 | 1.750 | 0.080 | -0.014 | 0.251 |
| Hobby | 0.032 | 0.066 | 0.500 | 0.621 | -0.096 | 0.161 |
| Insurance | -0.195 | 0.104 | -1.880 | 0.060 | -0.398 | 0.009 |
| cons | -0.750 | 0.456 | -1.640 | 0.100 | -1.644 | 0.144 |

Table A4: Results of probit model on 1st income group (Coef.)

| RDB | Coef. | Std. Err. | z | $P > z$ | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| lnTI1 | 0.091 | 0.087 | 1.040 | 0.296 | -0.079 | 0.261 |
| lnNTW | -0.074 | 0.022 | -3.420 | 0.001 | -0.117 | -0.032 |
| ADL | 0.112 | 0.031 | 3.600 | 0.000 | 0.051 | 0.172 |
| SRH1 | 1.033 | 0.390 | 2.650 | 0.008 | 0.269 | 1.796 |
| SRH2 | 0.790 | 0.368 | 2.150 | 0.032 | 0.068 | 1.512 |
| SRH3 | 0.381 | 0.371 | 1.030 | 0.305 | -0.347 | 1.108 |
| SRH4 | 0.289 | 0.387 | 0.750 | 0.455 | -0.469 | 1.047 |
| lnTFCC | 0.058 | 0.051 | 1.140 | 0.253 | -0.042 | 0.158 |
| lnTIFCC | 0.160 | 0.028 | 5.660 | 0.000 | 0.105 | 0.216 |
| Age | 0.008 | 0.009 | 0.910 | 0.363 | -0.009 | 0.025 |
| Gender | -0.308 | 0.154 | -2.000 | 0.046 | -0.610 | -0.006 |
| MS | 0.223 | 0.138 | 1.620 | 0.105 | -0.047 | 0.493 |
| Hobby | -0.181 | 0.131 | -1.390 | 0.165 | -0.438 | 0.075 |
| Insurance | -0.058 | 0.235 | -0.250 | 0.805 | -0.518 | 0.403 |
| cons | -2.042 | 0.861 | -2.370 | 0.018 | -3.730 | -0.355 |

Table A5: Results of probit model on 2st income group (Coef.)

| RDB | Coef. | Std. Err. | z | $P > z$ | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| lnTI2 | 0.631 | 0.421 | 1.500 | 0.134 | -0.194 | 1.457 |
| lnNTW | -0.068 | 0.019 | -3.620 | 0.000 | -0.104 | -0.031 |
| ADL | 0.137 | 0.031 | 4.430 | 0.000 | 0.076 | 0.198 |
| SRH1 | 1.243 | 0.436 | 2.850 | 0.004 | 0.388 | 2.098 |
| SRH2 | 0.965 | 0.422 | 2.290 | 0.022 | 0.139 | 1.792 |
| SRH3 | 0.581 | 0.422 | 1.380 | 0.168 | -0.246 | 1.407 |
| SRH4 | 0.429 | 0.431 | 0.990 | 0.320 | -0.416 | 1.273 |
| lnTFCC | 0.072 | 0.048 | 1.510 | 0.131 | -0.021 | 0.165 |
| lnTIFCC | 0.110 | 0.030 | 3.690 | 0.000 | 0.052 | 0.169 |
| Age | -0.008 | 0.009 | -0.960 | 0.335 | -0.025 | 0.009 |
| Gender | -0.223 | 0.121 | -1.830 | 0.067 | -0.460 | 0.015 |
| MS | 0.287 | 0.128 | 2.240 | 0.025 | 0.036 | 0.537 |
| Hobby | 0.045 | 0.116 | 0.380 | 0.701 | -0.183 | 0.272 |
| Insurance | -0.533 | 0.217 | -2.460 | 0.014 | -0.957 | -0.108 |
| cons | -3.707 | 2.274 | -1.630 | 0.103 | -8.164 | 0.751 |

Table A6: Results of probit model on 3rd income group (Coef.)

| RDB | Coef. | Std. Err. | z | $P > z$ | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| lnTI3 | -0.064 | 0.444 | -0.140 | 0.885 | -0.934 | 0.805 |
| lnNTW | -0.051 | 0.033 | -1.540 | 0.123 | -0.116 | 0.014 |
| ADL | 0.131 | 0.037 | 3.520 | 0.000 | 0.058 | 0.203 |
| SRH1 | 0.403 | 0.278 | 1.450 | 0.147 | -0.142 | 0.948 |
| SRH2 | 0.205 | 0.245 | 0.840 | 0.401 | -0.274 | 0.685 |
| SRH3 | -0.183 | 0.242 | -0.760 | 0.449 | -0.659 | 0.292 |
| SRH4 | -0.511 | 0.276 | -1.850 | 0.064 | -1.053 | 0.031 |
| lnTFCC | 0.063 | 0.050 | 1.250 | 0.212 | -0.036 | 0.161 |
| lnTIFCC | 0.111 | 0.033 | 3.390 | 0.001 | 0.047 | 0.175 |
| Age | 0.006 | 0.009 | 0.700 | 0.483 | -0.012 | 0.024 |
| Gender | -0.075 | 0.130 | -0.580 | 0.562 | -0.330 | 0.179 |
| MS | -0.098 | 0.138 | -0.710 | 0.478 | -0.368 | 0.172 |
| Hobby | 0.290 | 0.128 | 2.270 | 0.023 | 0.039 | 0.540 |
| Insurance | -0.070 | 0.235 | -0.300 | 0.766 | -0.531 | 0.391 |
| cons | -1.062 | 2.597 | -0.410 | 0.683 | -6.153 | 4.029 |

Table A7: Results of probit model on 4th income group (Coef.)

| RDB | Mar. Eff. | Std. Err. | z | $P > z$ | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| lnTI4 | -0.512 | 0.280 | -1.830 | 0.068 | -1.061 | 0.037 |
| lnNTW | -0.048 | 0.071 | -0.670 | 0.502 | -0.187 | 0.092 |
| ADL | 0.037 | 0.049 | 0.750 | 0.454 | -0.060 | 0.133 |
| SRH1 | 0.712 | 0.476 | 1.500 | 0.135 | -0.221 | 1.645 |
| SRH2 | 0.878 | 0.403 | 2.180 | 0.029 | 0.089 | 1.668 |
| SRH3 | 0.476 | 0.397 | 1.200 | 0.230 | -0.302 | 1.253 |
| SRH4 | 0.144 | 0.415 | 0.350 | 0.728 | -0.670 | 0.958 |
| lnTFCC | 0.198 | 0.061 | 3.230 | 0.001 | 0.078 | 0.318 |
| lnTIFCC | 0.170 | 0.046 | 3.720 | 0.000 | 0.081 | 0.260 |
| Age | 0.012 | 0.012 | 0.990 | 0.323 | -0.012 | 0.035 |
| Gender | 0.014 | 0.183 | 0.080 | 0.937 | -0.344 | 0.372 |
| MS | -0.133 | 0.186 | -0.710 | 0.477 | -0.498 | 0.233 |
| Hobby | -0.163 | 0.201 | -0.810 | 0.417 | -0.556 | 0.231 |
| Insurance | -0.274 | 0.193 | -1.420 | 0.155 | -0.652 | 0.104 |
| cons | 0.684 | 2.059 | 0.330 | 0.740 | -3.352 | 4.720 |

Table A8: Results of probit model on 1st wealth group (Coef.)

| RDB | Coef. | Std. Err. | z | $P > z$ | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| lnTI | 0.002 | 0.074 | 0.020 | 0.980 | -0.144 | 0.147 |
| lnNTW1 | -0.044 | 0.017 | -2.580 | 0.010 | -0.077 | -0.011 |
| ADL | 0.092 | 0.028 | 3.280 | 0.001 | 0.037 | 0.147 |
| SRH1 | 0.738 | 0.335 | 2.200 | 0.028 | 0.081 | 1.395 |
| SRH2 | 0.519 | 0.318 | 1.630 | 0.103 | -0.105 | 1.143 |
| SRH3 | 0.162 | 0.321 | 0.500 | 0.614 | -0.468 | 0.791 |
| SRH4 | -0.032 | 0.340 | -0.090 | 0.926 | -0.698 | 0.635 |
| lnTFCC | 0.112 | 0.041 | 2.760 | 0.006 | 0.033 | 0.192 |
| lnTIFCC | 0.125 | 0.025 | 5.010 | 0.000 | 0.076 | 0.174 |
| Age | -0.011 | 0.008 | -1.410 | 0.159 | -0.026 | 0.004 |
| Gender | -0.028 | 0.114 | -0.240 | 0.809 | -0.251 | 0.196 |
| MS | 0.153 | 0.112 | 1.370 | 0.169 | -0.065 | 0.372 |
| Hobby | -0.190 | 0.107 | -1.780 | 0.076 | -0.399 | 0.020 |
| Insurance | -0.677 | 0.285 | -2.370 | 0.018 | -1.236 | -0.118 |
| cons | 0.247 | 0.765 | 0.320 | 0.746 | -1.252 | 1.747 |

Table A9: Results of probit model on 2nd wealth group (Coef.)

| RDB | Coef. | Std. Err. | z | $P > z$ | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| lnTI | -0.069 | 0.080 | -0.86 | 0.39 | -0.226 | 0.088 |
| lnNTW2 | -0.452 | 0.332 | -1.36 | 0.173 | -1.103 | 0.199 |
| ADL | 0.138 | 0.034 | 4.03 | 0 | 0.071 | 0.204 |
| SRH1 | 0.356 | 0.299 | 1.19 | 0.234 | -0.230 | 0.942 |
| SRH2 | 0.147 | 0.267 | 0.55 | 0.581 | -0.377 | 0.672 |
| SRH3 | -0.157 | 0.268 | -0.59 | 0.558 | -0.683 | 0.368 |
| SRH4 | -0.505 | 0.294 | -1.72 | 0.086 | -1.082 | 0.071 |
| lnTFCC | -0.020 | 0.056 | -0.35 | 0.724 | -0.129 | 0.090 |
| lnTIFCC | 0.130 | 0.031 | 4.2 | 0 | 0.069 | 0.190 |
| Age | 0.008 | 0.009 | 0.83 | 0.405 | -0.010 | 0.026 |
| Gender | -0.256 | 0.134 | -1.91 | 0.056 | -0.518 | 0.006 |
| MS | 0.167 | 0.136 | 1.23 | 0.218 | -0.099 | 0.434 |
| Hobby | 0.093 | 0.124 | 0.75 | 0.454 | -0.150 | 0.336 |
| Insurance | -0.214 | 0.200 | -1.07 | 0.286 | -0.607 | 0.179 |
| cons | 3.792 | 3.954 | 0.96 | 0.338 | -3.959 | 11.543 |

Table A10: Results of probit model on 3rd wealth group

| RDB | Coef. | Std. Err. | z | $P > z$ | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| lnTI | -0.127 | 0.112 | -1.130 | 0.258 | -0.347 | 0.093 |
| lnNTW3 | -0.751 | 0.425 | -1.770 | 0.077 | -1.584 | 0.082 |
| ADL | 0.153 | 0.038 | 4.020 | 0.000 | 0.079 | 0.228 |
| SRH1 | 1.091 | 0.429 | 2.540 | 0.011 | 0.250 | 1.933 |
| SRH2 | 0.888 | 0.403 | 2.210 | 0.027 | 0.099 | 1.677 |
| SRH3 | 0.470 | 0.398 | 1.180 | 0.238 | -0.310 | 1.249 |
| SRH4 | 0.256 | 0.412 | 0.620 | 0.534 | -0.552 | 1.064 |
| lnTFCC | 0.043 | 0.053 | 0.820 | 0.415 | -0.060 | 0.146 |
| lnTIFCC | 0.094 | 0.037 | 2.530 | 0.011 | 0.021 | 0.167 |
| Age | 0.024 | 0.010 | 2.490 | 0.013 | 0.005 | 0.043 |
| Gender | -0.193 | 0.153 | -1.260 | 0.207 | -0.494 | 0.107 |
| MS | -0.004 | 0.154 | -0.030 | 0.980 | -0.305 | 0.298 |
| Hobby | 0.301 | 0.142 | 2.120 | 0.034 | 0.022 | 0.580 |
| Insurance | 0.100 | 0.257 | 0.390 | 0.695 | -0.402 | 0.603 |
| cons | 5.722 | 5.292 | 1.080 | 0.280 | -4.651 | 16.094 |

Table A11: Results of probit model on 4th wealth group (Coef.)

| RDB | Coef. | Std. Err. | z | $P > z$ | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| lnTI | -0.203 | 0.131 | -1.550 | 0.122 | -0.460 | 0.054 |
| lnNTW4 | 0.110 | 0.195 | 0.560 | 0.574 | -0.272 | 0.491 |
| ADL | 0.111 | 0.050 | 2.240 | 0.025 | 0.014 | 0.208 |
| SRH1 | 0.990 | 0.486 | 2.040 | 0.042 | 0.037 | 1.943 |
| SRH2 | 0.902 | 0.416 | 2.170 | 0.030 | 0.087 | 1.717 |
| SRH3 | 0.262 | 0.418 | 0.630 | 0.531 | -0.558 | 1.082 |
| SRH4 | 0.309 | 0.420 | 0.730 | 0.463 | -0.515 | 1.133 |
| lnTFCC | 0.225 | 0.069 | 3.240 | 0.001 | 0.089 | 0.361 |
| lnTIFCC | 0.195 | 0.050 | 3.920 | 0.000 | 0.098 | 0.293 |
| Age | -0.010 | 0.014 | -0.720 | 0.469 | -0.036 | 0.017 |
| Gender | 0.081 | 0.198 | 0.410 | 0.683 | -0.307 | 0.468 |
| MS | 0.156 | 0.194 | 0.800 | 0.421 | -0.224 | 0.537 |
| Hobby | 0.187 | 0.199 | 0.940 | 0.347 | -0.203 | 0.577 |
| Insurance | -0.375 | 0.202 | -1.850 | 0.064 | -0.772 | 0.022 |
| cons | -2.086 | 2.704 | -0.770 | 0.441 | -7.385 | 3.214 |

Table A12: Results of probit model on income and wealth dummies (Coef.)

| RDB | Coef. | Std. Err. | z | $P > z$ | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| TI1 | 0.601 | 0.205 | 2.930 | 0.003 | 0.200 | 1.003 |
| TI2 | 0.831 | 0.198 | 4.200 | 0.000 | 0.443 | 1.218 |
| TI3 | 0.539 | 0.200 | 2.690 | 0.007 | 0.147 | 0.931 |
| TI4 | 0.697 | 0.196 | 3.560 | 0.000 | 0.313 | 1.081 |
| TI5 | 0.786 | 0.193 | 4.070 | 0.000 | 0.408 | 1.164 |
| TI6 | 0.594 | 0.195 | 3.050 | 0.002 | 0.212 | 0.976 |
| TI7 | 0.647 | 0.195 | 3.320 | 0.001 | 0.265 | 1.030 |
| TI8 | 0.500 | 0.199 | 2.510 | 0.012 | 0.110 | 0.889 |
| TI9 | 0.609 | 0.195 | 3.130 | 0.002 | 0.228 | 0.991 |
| NTW1 | 0.542 | 0.153 | 3.550 | 0.000 | 0.243 | 0.841 |
| NTW2 | 0.209 | 0.153 | 1.360 | 0.173 | -0.092 | 0.509 |
| NTW3 | 0.236 | 0.153 | 1.540 | 0.123 | -0.064 | 0.537 |
| NTW4 | 0.155 | 0.154 | 1.010 | 0.313 | -0.146 | 0.457 |
| NTW5 | -0.010 | 0.157 | -0.060 | 0.951 | -0.316 | 0.297 |
| NTW6 | 0.162 | 0.153 | 1.060 | 0.290 | -0.138 | 0.461 |
| NTW7 | 0.023 | 0.159 | 0.140 | 0.886 | -0.290 | 0.335 |
| NTW8 | -0.293 | 0.175 | -1.670 | 0.094 | -0.635 | 0.050 |
| NTW9 | -0.242 | 0.175 | -1.380 | 0.167 | -0.585 | 0.101 |
| ADL | 0.158 | 0.016 | 9.800 | 0.000 | 0.127 | 0.190 |
| SRH1 | 0.955 | 0.170 | 5.610 | 0.000 | 0.622 | 1.289 |
| SRH2 | 0.690 | 0.157 | 4.380 | 0.000 | 0.381 | 0.998 |
| SRH3 | 0.246 | 0.157 | 1.560 | 0.118 | -0.062 | 0.555 |
| SRH4 | -0.009 | 0.167 | -0.050 | 0.959 | -0.335 | 0.318 |
| lnTFCC | 0.082 | 0.026 | 3.220 | 0.001 | 0.032 | 0.132 |
| lnTIFCC | 0.130 | 0.016 | 8.190 | 0.000 | 0.099 | 0.161 |
| Age | 0.009 | 0.004 | 2.080 | 0.037 | 0.001 | 0.018 |
| Gender | -0.082 | 0.068 | -1.210 | 0.225 | -0.216 | 0.051 |
| MS | 0.119 | 0.069 | 1.730 | 0.084 | -0.016 | 0.255 |
| Hobby | 0.018 | 0.065 | 0.270 | 0.785 | -0.109 | 0.144 |
| Insurance | -0.272 | 0.107 | -2.540 | 0.011 | -0.482 | -0.062 |
| Cons | -3.125 | 0.395 | -7.900 | 0.000 | -3.900 | -2.350 |

### 5.8.5 Appendix 5 Probit Model dropping the lifestyle factors

Table A13: Results of probit model dropping the lifestyle factors

| RDB | Coef. | Std. Err. | z | $P > z$ | 95% Conf.Interval | |
|---|---|---|---|---|---|---|
| lnTI | -0.060 | 0.038 | -1.55 | 0.122 | -0.135 | -0.016 |
| lnNTW | -0.067 | 0.011 | -6.15 | 0.000 | -0.089 | -0.046 |
| ADL | 0.098 | 0.015 | 6.76 | 0.000 | 0.070 | 0.127 |
| SRH1 | 0.892 | 0.162 | 5.50 | 0.000 | 0.574 | 1.210 |
| SRH2 | 0.667 | 0.151 | 4.40 | 0.000 | 0.369 | 0.963 |
| SRH3 | 0.242 | 0.152 | 1.59 | 0.111 | -0.056 | 0.540 |
| SRH4 | 0.023 | 0.160 | 0.14 | 0.888 | -0.291 | 0.336 |
| lnTFCC | 0.066 | 0.021 | 3.13 | 0.002 | 0.025 | 0.108 |
| lnTIFCC | 0.142 | 0.014 | 9.93 | 0.000 | 0.114 | 0.170 |
| Age | 0.005 | 0.004 | 1.28 | 0.202 | -0.003 | 0.013 |
| Gender | -0.110 | 0.061 | -1.73 | 0.084 | -0.226 | -0.014 |
| MS | 0.127 | 0.062 | 2.05 | 0.041 | 0.005 | 0.247 |
| cons | -1.323 | 0.406 | -3.26 | 0.001 | -2.119 | -0.528 |

# bibliography

Ando, A. and Modigliani, F. (1963). The ‘life-cycle’ hypothesis of saving: aggregate implications and tests, *American Economic Review* **53**: 55-84.

Arrow, K. J. (1963). Uncertainty and the welfare economics of medical care, *The American Economic Review***53**(5): 941-973.

Bound, J. and Burkhauser, R. (1999). Economic analysis of transfer programs targeted on people with disabilities, in: Card, D. and Ashenfelter, O. (Eds.), *Handbook of Labor Economics*, 3417-3528.

Caballero, R. (1991). Earning uncertainty and aggregate wealth accumulation, *American Economic Review* **81**: 839-71.

Caroll, C. and Samwick, A. (1998). How important is precautionary saving?, *The Review of Economics and Statistics* **80**: 410-419.

Castries, D. H. (2009). Ageing and Long-Term Care: Key Challenges in Long-Term Care Coverage for Public and Private Systems, *Geneva Papers On Risk And Insurance: Issues And Practice* **34**(1):24-34.

Cutrona, S., Woolhandler, S., Lasser, K. E., Bor, D. H., McCormick, D. and Himmelstein, D. U. (2008). Characteristics of recipients of free prescription drup samples: A nationally representative analysis, *American Journal of Public Health* **98**(2): 284-289.

Chen, Y. P. (2001). Funding long-term care in the United States: The role of private insurance Geneva Papers, *Risk and Insurance* **26**: 656-666.

Cremer, H., Gahvari, F. and Pestieau, P. (2017). Uncertain altruism and the provision of long term care, *Journal of Public Economics* **151**:12-24.

Cropper, M. L. (1977). Health investment in health, and occupational choice. *Journal of Political Ecomomy* **85**:1273-1294.

Dardanoni, V. (1991). Precautionary savings under income uncertainty: A cross-Sectional analysis. *Applied Economics* **23**: 153-160.

Davies, J. B. (1981). Uncertain lifetime, consumption, and dissaving in retirement, *Journal of Political Economy* **89**: 561-577.

Danziger, S., Van Der Gaag, J., Smolensky, E. and Taussig M. K. (1982-1983). The life-cycle hypothesis and the consumption behavior of the elderly, *Journal of Post Keynesian Economics* **Winter** V(2): 208-227.

De Meijer, C., Koopmanschap, M., d' Uva, T. and van Doorslaer, E. (2011). Determinants of long-term care spending: Age, time to death or disability?, *Journal Of Health Economics* **30**(2): 425-438.

Department of Health (DP) (2009). *Shaping the Future of Care Together*. Department of Health, London.

Diamond, P. and Hausman, J. (1984). Individual retirement and savings behavior, *Journal of Public Economics* **23**(1-2): 81-114.

Engen, E. (1993). *Estimation of dynamic models of precautionary saving and life-cycle consumption using panel data*, UCLA.

European Commission (2008). *Long-term care in the European Union*. Directorate-General for Employment, Social Affairs and Equal Opportunities, Brussels.

Falkingham, J., Evandrou, M., McGowan, T., Bell, D. and Bowes, A. (2010). Demographic issues, projections and trends: older people with high support needs in the uk, *ESRC Centre for Population Change and the Joseph Rowntree Foundation Working Paper Series*, Southampton.

Fehr, H. and Uhde, J. (2014). Means-testing and economic efficiency in pension design, *Economic Modelling* **44**: 57-67.

Foti, D. and Koketsu, J. S. (2013). Activities of daily living, in: Pendleton, H. and Schultz-Krohn, W. *Pedretti's occupational therapy practice skills for physical dysfunction* (7th edition), St Louis: Mosby, pp 6-9

Guiso, L., Jappelli, T. and Terlizzese, D. (1992). Earnings Uncertainty and Precautionary Saving. *Journal of Monetary Economics* **30**: 307-337.

Grossman, M. (1972a). On the concept of health capital and the demand for health, *Journal of Political Economy* **80**(2): 223-255.

Grossman, M. (1972b). The demand for health: a theoretical and empirical investigation. *The National Bureau of Economic Research Working Paper*, New York.

Gupta, A. and Li, L. (2007). Integrating long-term care insurance purchase decisions with saving and investment for retirement, *Insurance: Mathematics And Economics* **41**(3): 362-381.

Hancock, R. M., Morciano, M., Pudney, S. E. and Zantomio, F. (2009). Health Select Committee social care inquiry: Written evidence, *ISER Working Paper Series No. 2009-07*, Institute for Social and Economic Research.

Hancock, R. M., Morciano, M., Pudney, S. E. and Zantomio, F. (2010). Attendance Allowance and Disability Living Allowance claimants in population: Is there a difference in their economic circumstances?, *ISER Working Paper Series No.2010-27*, Institute for

Social and Economic Research

Hancock. R. M., Wittenberg, R., Hu, B., Morciano, M. and Comas-Herrera, A. (2013). Long-term care funding in england: an analysis of the costs and distributional effects of potential reforms, *PSSRU Discussion Paper 2857*, Personal Social Services Research Unit, London.

Hemmi, N., Tabata, K. and Futagami, K. (2006). The long-term care problem, precautionary saving, and economic growth, *Journal of Macroeconomics* **29**(1): 60-77.

Holmes, P., Lynch, M., and Molho I. (1991). An econometric analysis of the growth in the numbers claiming Invalidity Benefit: An overview, *Social Policy* **20**(1): 87-105.

Hubbard, R. G., Skinner, J. and Zeldes, S. P. (1994a). The Importance of Precautionary Motives in Explaining Individual and Aggregate Saving, *Carnegie-Rochester Conference Series on Public Policy* **40**: 59-125.

Hubbard, R. G., Sknner, J. and Zeldes, S. P. (1994b). Expanding the Life-Cycle Model: Precautionary Saving and Public Policy. *A.E.R. Papers and Proc* **84**: 174-79.

Hubbard, R. G., Skinner, J. and Zeldes, S. P. (1995). Precautionary saving and social insurance, *Journal of Political Economy* **103**: 360-399.

Jappelli, T., Pistaferri, L. and Weber, G. (2006). Health Care Quality, Economic Inequality, and Precautionary Saving, *Health Economics* **16**(4): 327-346.

Jitsuchon, S. and Saito, M. (1995). Precautionary saving, growth and welfare: A cross-country study, *Economics Department Working Paper Series 9509*, University of British Columbia.

King, M. A. and Dicks-Mireaux, L. (1982). Asset holdings and the life-cycle, *Economic Journal***92**(366): 247-267.

Kotlikoff, L. J. (1989). Health expenditure and precautionary savings, in: Kotlikoff, L. J. (Ed.), *What determines savings?* Cambridge Massachusetts: The MIT Press.

Kraus, M., Riedel, M., Mot, E., Willem, P., Rhrling, G. and Czypionka, T. (2010). A typology of long-term care systems in Europe, *ENEPRI Research Report Ner 91*, European Network of Economic Policy Research Institutes.

Kumru, C. S. and Piggott, J. (2009). *An analysis of means tested social pensions*. A working paper of University of New South Wales.

Leland, H. E. (1968). Saving and uncertainty: the precautionary demand for saving, *Quarterly Journal Of Economics* **82**: 465-473.

McVicar, D. (2008). Why have UK disability bene

t rolls grown so much? *Journal of Economic Surveys***22**: 114-139.

Mirer, T. W. (1979). The Wealth-Age Relation Among the Aged, *American Economic Review* **69**: 435-443.

Mizushima, A. (2009). Intergenerational transfers of time and public long-term care with an aging population, *Journal Of Macroeconomics* **31**(4): 572-581.

Modigliani, F. and Brumberg, R. (1954). Utility analysis and the consumption function: An interpretation of cross-section data, in: Kurihara, K. K. (Ed.), *Post-Keynesian Economics*, New Brunswick: Rutgers University Press.

NAO (2003). Progress in improving the medical assessment of incapacity and disability benefits. *House of Commons: Report by the Comptroller and Ausitor General*, National Audit Office, London.

OECD (2011). *Help Wanted? Providing and Paying for Long-Term Care*, OECD Publishing, Paris.

OECD (2015). *Health at a Glance 2015: OECD Indicators*, OECD Publishing, Paris.

OECD (2017). *Saving rate*. https://data.oecd.org/natincome/saving-rate.htm

Palumbo, M. G. (1992). *Health uncertainty and optimal consumption near the end of the life cycle*, University of Virginia Ph.D. Dissertation.

Palumbo, M. G. (1999). Uncertain medical expenses and precautionary saving near the end of the life cycle, *Review of Economic Studies* **66**: 395–421

Pudney, S. (2009). Participation in disability benefit programmes. A partial identification analysis of the British Attendance Allowance system, *ISER Working Paper Series No.2009-19*, Institute for Social and Economics Research.

Pudney, S. (2010). Disability Benefits for Older People: How Does the UK Attendance Allowance System Really Work?, *ISER Working Paper Series No.2010-02*, Institute for Social and Economics Research.

Picone, G. M. and Wilson, R. M. (1998). The effect of uncertainty on the demand for medical care, health capital and wealth, *Journal of Health Economics* **17**: 171-185.

Rodriguez, A. (1999). Precautionary saving and economic growth, *Journal of Macroeconomics* **21**(2): 219-239.

Sefton, J., Van de Ven, J. and Weale, M. (2008). Means testing retirement benefits: fostering equity or discouraging savings, *The Economic Journal* **118**(528): 556-590.

Skinner, J. (1985). Variable lifespan and the intertemporal elasticity of consumption, *Review of Economics and Statistics* **67**: 616-623.

Skinner, J. (1988). Risky Income, Life Cycle Consumption, and Precautionary Savings. *Journal of Monetary Economic* **22**: 237-55.

TWB (2017). *Out-of-pocket health expenditure*. https://data.worldbank.org/indicator/

Vastel, K., Naper, S. O., Claussen, B. and Dalqard, O. S. (2007) Does Mastering have an effect on disability pensioning independent of health, and may it explain divides of education in the Oslo Health Survey? *Scandinavian Journal of Public Health* **35**: 157-163.

Vidangos, I. (2009). Household Welfare, Precautionary Saving, and Social Insurance under Multiple Sources of Risk. *Finance and Economics Discussion Series No. 2009-14*, Board of Governors of the Federal Reserve System (U.S.)

Wanless, D. (2006). *Securing good care for older people: Taking a long-term view*. London: King's Fund.

White, B. B. (1978). Empirical tests of the life-cycle hypothesis, *American Economic Review* **68**: 547-560.

Wouterse, B., Huisman, M., Meijboom, B. R., Deeg, D. J. and Polder, J. J. (2013). Modeling the relationship between health and health care expenditures using a Latent Markov model, *Journal of Health Economics* **32**(2):423-439.

Zhao, K. (2017). Social Insurance, private health insurance and individual welfare, *Journal of Economic Dynamics and Control* **78**: 102-107.